DELAWARE RIVER BASIN
KINNEYVILLE CREEK, WAYNE COUNTY

PENNSYLVANIA

LAKE COMO DAM

NDI ID NO. PA-00130
DER ID NO. 64-16

ROBERT K. AND LINDA F. GILCHRIST

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared by
Geo-Technical Services, Inc.
CONSULTING ENGINEERS & GEOLOGISTS
851 S. 19th Street
Harrisburg, Pennsylvania 17104

Original contains color plates: All DTIC reproductions will be in black and white.

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

AUGUST 1981

DELAWARE RIVER BASIN

KINNEYVILLE CREEK, WAYNE COUNTY

PENNSYLVANIA

LAKE COMO DAM

NDI ID NO. PA-00130
DER ID NO. 64-16

ROBERT K. and LINDA F. GILCHRIST

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DACW31-81-C-0019

Prepared by

GEO-Technical Services, Inc.
Consulting Engineers & Geologists
851 S. 19th Street
Harrisburg, Pennsylvania 17104

For

Department of the Army
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

August 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditon of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonable possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
BRIEF ASSESSMENT OF GENERAL CONDITION
AND
RECOMMENDED ACTION

Name of Dam:	Lake Como Dam NDI ID No. PA-00130 DER ID No. 64-16
Size:	Small (12.2 feet high; 939 acre-feet)
Hazard Classification:	Low
Owner:	Robert K. and Linda F. Gilchirst R.D., Lake Como, Pa. 18437
State Located:	Pennsylvania
County Located:	Wayne
Stream:	Kinneyville Creek
Date of Inspection:	June 24, 1981

Based on visual inspection, field survey, available records, calculations and past operational performance, Lake Como Dam is judged to be in fair condition. Based on the size (small) and hazard classification (low) of the dam and in accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility varies between the 50-year and the 100-year flood. Due to the relatively large storage capacity in the reservoir, the 100-year flood is the selected SDF. The present spillway capacity of the dam is 535 cfs (cubic feet per second). Whereas the estimated peak inflow of the 100-year flood is 1240 cfs. The outflow from the Lake is controlled by a road culvert, located some 200 feet upstream of the dam.

Because the spillway capacity of 535 cfs is less than the estimated 1240 cfs peak discharge of the 100-year flood, the spillway capacity is rated as inadequate.

Considering the rotted condition of the plank sheeting to the right of the spillway wall, further deterioration of the sheeting may cause leakage and the stability of the dam could, in time, be affected.

Brush and small trees on top of the dam crest and at close proximity to the toe indicate that maintenance of the dam is unsatisfactory.

The following investigations and remedial measures are recommended for immediate implementation by the owner.

(1) Increase the spillway capacity to adequately pass the 100-year flood without overtopping the dam.

(2) Remove brush and small trees from the crest of the dam and the trees in the proximity of the toe of the dam.

(3) Periodically inspect the condition of the plank sheeting and monitor conditions at the toe of the dam. Should leakage be observed at the downstream toe, take appropriate remedial measures.

All investigations, monitoring programs and design of remedial measures should be performed by a Professional Engineer, experienced in the design and construction of dams.

In addition, it is recommended that the owner take the following precautionary operation and maintenance measures:

(1) After satisfactory implementation of remedial measures resulting from the recommended additional investigations, institute a formal inspection and maintenance program for the dam. As presently required by the Bureau of Dams and Waterway Management of PENNDER, the program shall include an annual inspection of the dam by a Professional Engineer, experienced in the design and construction of dams. Deficiencies found during annual inspections should be remedied as necessary.

Submitted by:

GEO-TECHNICAL SERVICES, INC.

GIDEON YACHIN, P.E.

Date: August 31, 1981

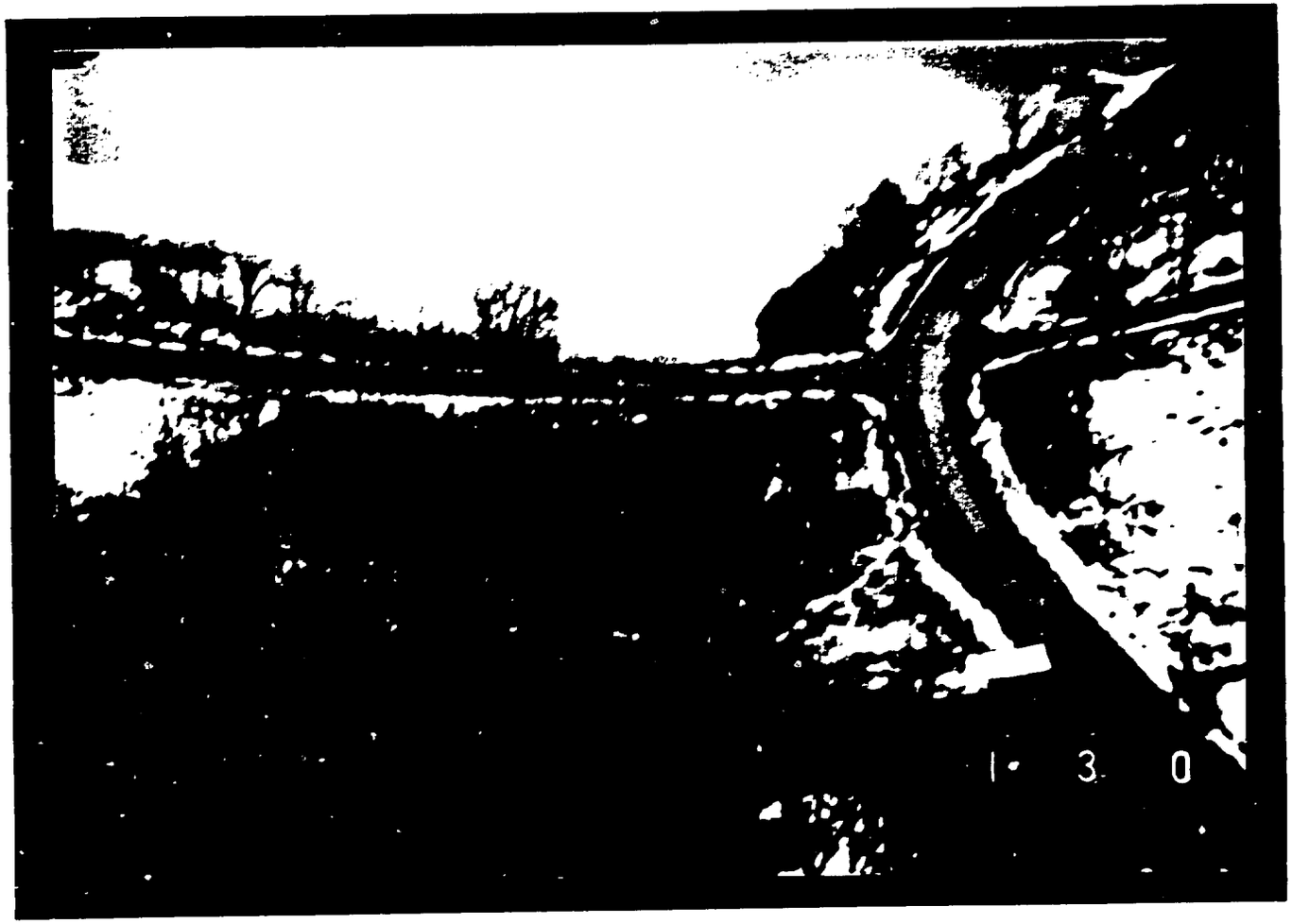
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer
Date: 10 Sept 81

LAKE COMO DAM (PA-00130)

SHOWING ROAD CROSSING UPSTREAM OF DAM (SEE ARROW IN FOREGROUND)



OVERVIEW

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

LAKE COMO DAM

NDI# PA-00130, PENNDER# 64-16

SECTION 1

GENERAL INFORMATION

1.1 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.2 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.3 Description of Project.

a. Dam and Appurtenances: Lake Como Dam is a composite structure consisting of an upstream earth embankment and a downstream near-vertical stone wall. The dam is 12.2 feet high and 196 feet long, including spillway. The spillway is located near the middle of the dam, consisting of a 28.3-foot long sharp crested concrete weir, terminating with vertical concrete endwalls. There are no facilities to drain the reservoir.

b. Location: Lake Como Dam is located on Kinneyville Creek in Preston Township, Wayne County, 1.7 miles southeast of the intersection of State Routes 247 and 370 and 0.3 mile southwest of the Village of Lake Como, Pennsylvania. The dam and reservoir are contained within the Lake Como, Pennsylvania 7.5 minute Series USGS Quadrangle Map, at Latitude N41°50'58" and Longitude W75°20'34". A Location Map is shown in Exhibit E-1.

c. Size Classification: Small (12.2 feet high, 939 acre feet storage capacity at top of dam).

d. Hazard Classification: Low (see paragraph 3.1e).

e. Ownership: Robert K. and Linda F. Gilchrist, R. D., Lake Como, Pennsylvania 18437.

f. Purpose of Dam: The original purpose of the impounded water was for water power, ice harvesting and recreation. Presently, the lake is used for recreation.

g. Design and Construction History: Information related to the design and construction of the dam is not available. Data obtained from the Pennsylvania Department of Environmental Resources (PENNDER) indicate that the dam was in existence prior to the 1914 "Survey of Lakes in Pennsylvania". a 1917 report indicates that the masonry and earthfill dam was 12-feet high, 165 feet long and having a storage capacity of 242 million gallons (± 700 acre-feet) at normal pool. The dam was owned by the H. R. Underwood and Company of New York City, New York. The dam consisted of a dry stone wall, the downstream face of which was vertical, and an upstream earthfill, sloping off very flatly from the stone wall. The above cited report also indicates that . . ."*Between the stone wall and the earthfill, the entire dam has been sheathed with 2" plank, the joints of which are lapped with 1" boards*". The spillway was located near the center of the dam and consisted of a rectangular wooden plank sluiceway. The spillway crest was 18.3 feet long and 3.4 feet below the crest of the dam. The spillway capacity was reported as 378 cfs (cubic feet per second). The dam was repaired circa 1931 to reduce leakage.

On September 2, 1952, an application was made by Robert K. and Linda F. Gilchrist (the present owners) for the reconstruction of the spillway and repair of the upstream face of the dam. Permit to reconstruct the dam was granted by the Pennsylvania Water and Power Resources Board on October 22, 1952. Reconstruction work started on October 24, 1953 and was completed by December 2, 1953.

h. Normal Operational Procedure: The pool is maintained at the spillway crest elevation with excess inflow discharging over the spillway into Kinneyville Creek.

1.4 Pertinent Data.

a. Drainage Area: (square miles)	3.79
b. Discharge at Damsite: (cfs)	
Maximum Known Flood at damsite since reconstruction	Not Known
Spillway capacity at maximum pool elevation	
Design Conditions	890
Existing Conditions	535
c. Elevation: (feet above msl) See paragraph 3.1a for datum	
Top of Dam	
Design Conditions for the 1952 reconstruction	1512.0
Existing Conditions (lowest point on top of dam)	1511.2
Maximum pool	
Design Conditions for the 1952 reconstruction	1512.0
Existing Conditions	1511.2
Normal Pool (spillway crest)	1508.0
Streambed at toe of dam	1499.0
Tailwater on 6/24/81	1499.3

d. Reservoir Length: (feet)

Normal pool	4600
Maximum pool (at top of dam)	5930

e. Storage: (acre-feet)

Normal pool	675
Maximum pool	
Design Conditions	Not Known
Existing Conditions	939

f. Reservoir Surface: (acres)

Normal pool	80
Maximum pool	
Design Conditions	Not Known
Existing Conditions	85

g. Dam:

Type - Composite Earthfill & Rubble Masonry

Length (feet) (including spillway)	196
Height (feet)	12.2
Top Width (feet)	
Design Conditions	12.5
Existing Conditions, varies from 12.5 to 13.5	

Side Slopes
Upstream face sheeting - varies from 1V:1H to 1V:0.9H
Downstream face - near vertical (see par. 3.1b)

Zoning - See Type, above

Cut-off - Plank sheeting, approximately 3' below reservoir bottom at the upstream face of the dam.

Impervious Core	See Cut-off
Grout Curtain	None

h. Diversion and Regulating Tunnel: None

i. Spillway:

Type - Sharp crested concrete weir

Length of Weir (feet)	28.3
Crest Elevation	1508.0

Upstream Channel - 200' long shallow channel, average depth 1.5'

Downstream Channel - Natural Streambed

j. Outlet Works:	Non Provided
Type	Not Applicable
Length (feet)	Not Applicable
Closure and Regulating Facilities	None
Access	Not Applicable

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available: There is no available information related to the design and construction of the dam. The earliest information available consists of a 1917 report, accompanied with photographs, prepared by the Water Supply Commission of Pennsylvania. Inspection Reports, accompanied with photographs, depict the condition of the dam in 1920, 1930, 1938 and 1941. Plan views of the dam, showing conditions in 1952 and proposed reconstruction, are presented in Exhibits E-2 and E-3, Appendix E.

b. Design Features:

(1) Dam: The dam is a composite structure consisting of a near-vertical dry stone wall that retains a rockfill embankment. The upstream face of the dam is lined with pine sheeting spiked into nailers within the rockfill. The pine sheeting lining has a slope of 1V:0.9H (1 Vertical on 0.9 Horizontal) to 1V:1H and is protected with a clay blanket, from the bottom of the sheeting to approximately one foot below the spillway crest elevation. Features of the dam are illustrated in photographs, presented in Appendix E.

(2) Spillway: The spillway was to consist of a 30-foot long sharp crested concrete weir terminating with near-vertical concrete end-walls and a concrete slab downstream apron, terminating at the downstream stone wall, approximately 7 feet above the streambed.

c. Specific Design Data and Criteria: The design of the reconstructed spillway was to provide spillway capacity of 900 cfs.

2.2 Construction Records.

There are no records available for evaluation of construction methods and the classification or quality of materials placed in the dam.

2.3 Operational Records.

Review of inspection reports and correspondence indicates that the leakage through the dam exceeded the inflow into the lake during dry periods. The dam was repaired in 1931 to reduce leakage. However, leakage through the dam was reported in 1935, 1938, 1941 and 1948. In 1953 the dam was repaired and the spillway was reconstructed. The present normal operation of the facility is described in paragraph 1.3h, Section 1.

2.4 Other Investigations.

Since reconstruction of the spillway and repair of the dam in 1953, the dam was inspected in April 1965 and found to be in fair to good condition.

2.5 Evaluation.

a. Availability of Data: Although "as-built" plans for the dam and the spillway are not available, data obtained from PENNDER files provide information relative to the chronology of construction.

b. Adequacy: In the absence of "as-built" plans and formal construction records, assessment of the structural integrity of the dam and its safety must be based on the combination of available cited data, visual inspection, performance history, as well as hydrologic and hydraulic analysis (see Section 5).

c. Validity: There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Observations.

a. General: The overall appearance of the dam is fair. Deficiencies observed during the field inspection are noted on the General Plan, Exhibit A-1, and are described in the subsequent paragraphs. The profile and typical sections of the dam are presented in Exhibits A-2 and A-4 and are based on field survey made on the day of the inspection. The survey datum for this inspection is based on the normal pool elevation 1508 above mean sea level established by the USGS (see Exhibit E-1, Appendix E). To convert the vertical dimensions as shown on the design drawing (Exhibit E-3) to the elevations used in this report, it is necessary to designate elevation 1508 to the sharp crested concrete weir. On the inspection date (June 24, 1981), the lake level was 0.1 foot above the spillway crest. Visible features of the dam are depicted in photographs presented in Appendix C.

b. Dam: Observations made during the field inspection reveal that the horizontal alignment of the dam is concaved in an upstream direction (see Exhibit A-1, Appendix A). The present alignment is similar to the alignment of the dam in 1965 (see upstream face photograph, Exhibit E-7). The upstream plank sheeting extends 33 feet to the left and the right of the spillway. Beyond the termination of the sheeting, a 3-foot wide loose stone wall extends on each abutment of the dam for a total distance of 102 feet. The purpose of this loose stone wall, protruding from a few inches to a maximum of 1.5-feet above the ground level, appears to be for protection of the abutments in the event of overtopping. The plank sheeting on the upstream face of dam extends above the crest of the rockfill embankment, as shown in Exhibit A-4 and photograph 5, Exhibit C. The sheeted upstream slope of the dam has a slope of 1V:0.9H (1 Vertical on 0.9 Horizontal). The plank sheeting to the right of the spillway endwall is rotted. The top width of the rockfill crest varies between 12.5 to 13.5 feet. The right end of the crest is covered with brush and small trees.

The downstream face of the dam appears to be in good condition. The stone wall left of the spillway endwall has a vertical face for the first top 4 feet, terminating with a one-foot wide horizontal ledge. Between the ledge and the toe of the dam, the stone wall has a batter of 1V:0.4H (see Section A, Exhibit A-4, and Photographs 9 and 11, Appendix C). To the right of the spillway endwall, the downstream face of the dam is near vertical, as shown in photograph 12, Appendix C. There was no visible seepage nor leakage on the downstream face or at the toe of the dam. Trees up to 15-inches in diameter are located at the toe of the dam (see photographs 10 and 11, Appendix C).

c. Appurtenant Structures:

(1) Spillway: The design features of the reconstructed spillway are described in paragraph 2.1b(2). The appearance of the spillway is good, as illustrated in photographs 5 thru 9, Appendix C. The sharp crested

concrete weir is 28.3 feet long. Flow over the weir drops onto a concrete apron. The 14 foot long apron, having a 2.5 percent slope, terminates at the downstream face of the dam, 7 feet above the streambed. Flow over the spillway plunges over dumped rock at the toe of the dam to prevent scour and undermining of the toe (see Exhibits A-1, A-2 and A-4, Appendix A, and photograph 9, Appendix C).

(2) Outlet Works: There are no visible means to draw down the reservoir below the spillway crest.

d. Reservoir Area: The watershed is predominantly wooded, rising from the normal lake elevation 1508 to elevation 2000 above mean sea level. The slopes near the lake proper vary from approximately 26% above the right bank to 16% above the left bank, some 2000 feet upstream of the dam. The abutments at the dam site have an 8% slope. There was no evidence of slide activity on the steeper slopes or on the dam abutments that can endanger the safety of the dam. There are two major inlets into Lake Como. Of the total 3.79 square mile drainage area of the Lake, approximately 25% contribute to the inflow at the southern inlet and the remaining 75% to the inflow at the northwestern inlet (see Exhibit E-1, Appendix E). Approximately 6% of the entire watershed area consists of swamps and small natural lakes. Both permanent and seasonal homes are located along the shore of Lake Como, between the two lake crossings (see Photographs 14 & 15, Appendix C and Exhibit E-1, Appendix E). The first road crossing of the Lake is located 200 feet upstream of the dam. A culvert, consisting of two 7.3 foot diameter steel pipes and a 72" span by 44" corrugated metal pipe-arch, located at the first crossing (see Photographs 1, 3 & 4, Exhibit C), replaced an old 30-foot span bridge at this location (see Exhibit E-6, Appendix E). The second road crossing is located 3000 feet upstream of the dam, consists of two 7-foot diameter corrugated metal pipes. On the day of the inspection, the Lake level was 8.3 feet below the low point on the top of the road; whereas, the invert of the lowest pipe was 2.2 feet below the Lake level (see Photograph 15, Appendix C). Pertinent watershed features are presented in Exhibit E-1, Appendix E. Geologic features of the area are described in Appendix F.

e. Downstream Channel: The average slope of the stream channel, along the first 2000 feet downstream of the dam, is 2%. The stream crosses under State Route 247, through a box culvert (8' high and 20' span) located 1500 feet downstream of the dam. The low point on top of the road is 30 feet above the invert of the culvert. Development in the flood plain is limited to the first 1600 feet downstream of the dam and consists of two homes and a lumber company storage building (see Photographs 17, 18 and 19, Appendix C). The first floor elevation of the homes is between 11 and 15 feet above the streambed (see Appendix A, page 8 of 8). The survey indicates that loss of life is not expected and that minimal amount of property damage may occur should the dam fail. Consequently, the Lake Como Dam is classified as a low hazard structure.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

The reservoir is maintained at normal pool level with the excess inflow discharging over the spillway into the downstream channel. There are no means to draw down the reservoir below the spillway crest elevation.

4.2 Maintenance of Dam.

There is no formal maintenance program for the dam at the present time.

4.3 Maintenance of Operating Facilities.

There are no operating facilities for the dam.

4.4 Warning System in Effect.

There is no emergency operating and warning system in effect at the present time.

4.5 Evaluation.

The owner should institute regularly schedules maintenance inspections. Brush and trees should be removed from the crest of the dam near the right abutment and from the toe of the dam. In view of the rotted condition of the plank sheeting, to the right of the spillway, and the past history of leakage through the plank sheeting, the owner should include monitoring the conditions at the toe of the dam within the scope of the scheduled inspections.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Design Data.

a. The permit given by the Pennsylvania Water and Power Resources Board for the reconstruction of the spillway and the repair of the dam stipulated that the spillway should pass 900 cfs (cubic feet per second) without overtopping the dam. To obtain this capacity for the design head (4 feet) and weir crest length (30 feet) shown in Appendix E, it appears that a discharge coefficient of 3.75 was adopted for the design of the spillway. Hydraulic analysis presented in Appendix D employed a discharge coefficient of 3.3, which better represents the conditions of the constructed spillway. The total drainage area above the dam is 3.79 square miles.

5.2 Experience Data.

There are no records available to indicate the maximum pool attained by the reservoir during past floods, and no flow records are available for the Kinneyville Creek. The owner stated that the dam did not overtop since the reconstruction of the spillway in 1953.

5.3 Visual Observations.

Based on the visual inspection and field survey, described in Section 3 of this report, the observations relevant to hydrology and hydraulics are evaluated below:

a. Dam: The top of dam has an irregular profile and its lowest point is at elevation 1511.2 (see Exhibit A-2, Appendix A). Top of dam elevations refer to the top of the plank sheeting on the upstream face of the dam.

b. Spillway: The 28.3 foot long spillway crest is at elevation 1508.0, or 3.2 feet below the lowest point on the crest of the dam. The present spillway deviates from the design drawings (see Appendix E), being 1.7 feet shorter and providing a maximum head of 3.2 feet.

c. Reservoir Area: The dam was constructed in a narrow and shallow outlet channel of a natural lake. At normal pool elevation, this channel is 55 to 75 feet wide and 1 to 3 feet deep along a distance of 200 feet upstream of the dam. Therefore, consideration was given to the effect of the velocity in the approach channel, or the forebay, on reservoir levels during floods (see Sheet D-7, Appendix D). Instantaneous outflow of water from the reservoir, resulting from a dam failure, is limited to the depth of water in the 200 foot long forebay at the time of failure. A culvert under a road, crossing the lake at its natural outlet, is located 200 feet upstream of the dam. During flood periods, the outflow from the lake is controlled by the culvert. There are no visible indications to suggest drastic change in the prevailing watershed land use to significantly alter the rate of inflow into the reservoir during extreme floods.

d. Downstream Conditions: The spillway and dam crest overtopping discharge capacities are not affected by tailwater conditions for the entire range of discharges considered in this study (see Sheet D-4, Appendix D). Failure of the dam may result in flooding of one dwelling, located on the left bank of Kinneyville Creek and approximately 1300 feet downstream of the dam. The observed downstream conditions indicate that a low hazard classification is warranted for the Lake Como Dam.

5.4 Method of Analysis.

Hydrologic and hydraulic evaluation was made in accordance with the procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore District, Phase I Safety Inspection of Dams. The effect of the culvert under the road, crossing the lake upstream of the dam, on the rate of reservoir outflow during floods was estimated by approximate method (see Sheet D-2, Appendix D).

5.5 Summary of Analysis.

a. Spillway Design Flood: According to the criteria established by the Office of the Chief of Engineers (OCE) for the size (small) and hazard potential (low) of Lake Como Dam, the Spillway Design Flood (SDF) is between 50-year Flood and the 100-year Flood. Should the dam fail, at least 600 acre-feet of storage could be lost from the Lake (see Appendix D, Sheet D-3). Therefore, based on the relatively large storage capacity in the reservoir and in accordance with the recommended guidelines, the 100-year flood is selected as the SDF for the Lake Como Dam.

b. Results of Analysis: Hydrologic and hydraulic analyses is presented in Appendix D. The analysis reveals that under the prevailing top of dam elevations, the spillway discharge is 535 cfs when the water surface upstream of the dam reaches the low point on the dam crest (El.1511.15). The discharge of 535 cfs through the upstream culvert corresponds to lake level elevation 1511.74, or approximately 0.6 foot difference in elevation between the crest of the dam and the surface of the lake. Consequently, the flow from the reservoir is controlled by the road culvert during floods. The estimated peak inflow into Lake Como resulting from a 100-year flood is 1,240 cfs.

c. Spillway Adequacy: Because the spillway capacity of 535 cfs is less than the estimated 1240 cfs peak discharge of the 100-year flood, the spillway capacity is rated as inadequate.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations.

The visual inspection of Lake Como Dam is described in Section 3. Observations that are relevant to structural stability of the dam and spillway are evaluated below.

a. Dam: The plank sheeting on the upstream face of the dam are rotted. Past history of the dam indicates that the integrity of the sheeting is essential to the structural stability of the dam (see Paragraphs 1.3g, 2.3 and 6.4). Therefore, further deterioration of the plank sheeting may result in the resumption of leakage. There was no visible leakage through the dam on the day of the inspection, and the facility is judged to be structurally stable. The owner should monitor the conditions at the toe of the dam. Should leakage develop due to additional deterioration of the plank sheeting, appropriate action should be taken to preserve the structural stability of the dam.

b. Spillway: The concrete weir, endwalls and the concrete slab of the spillway apron are in good condition. The dumped sandstone boulders at the toe of the dry stone wall appear to provide adequate protection against undermining of the spillway.

6.2 Design and Construction Data.

Available design and construction data are inadequate to assess the present stability of the dam; thus, the evaluation is based on visual inspection.

6.3 Post-Construction Changes.

Reconstruction of the spillway in 1953 improved the structural condition of the dam. The conditions of the dam prior to and after its reconstruction are illustrated in Exhibits E-6 and E-7, respectively. Comparison between photographs 5 through 8, Appendix C, and Exhibit E-7, Appendix E, indicates that the appearance of the dam since 1965 remains virtually unaltered.

6.4 Past Performance.

Information cited in Paragraphs 1.3g and 2.3 indicates that the dam was repaired at least twice since its construction. The repairs were necessitated to prevent leakage through the dam, attributable to the plank sheeting on its upstream face.

6.5 Seismic Stability.

The dam is located in Seismic Zone 1 and may be subject to minor earthquake induced dynamic forces. As the dam appears to be stable under static loading conditions, it is assumed to be able to withstand minor earthquake loadings in this zone.

SECTION 7

ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety:

(1) Based on the visual inspection, field survey, available records, calculations and past operational performance, Lake Como Dam is judged to be in fair condition. Based on the size (small) and hazard classification (low) of the dam and in accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility varies between the 50-year and the 100-year flood. Due to the relatively large storage capacity in the reservoir, the 100-year flood is the selected SDF. The present spillway capacity of the dam is 535 cfs (cubic feet per second). Whereas the estimated peak inflow of the 100-year flood is 1240 cfs. The outflow from the Lake is controlled by a road culvert, located some 200 feet upstream of the dam.

Because the spillway capacity of 535 cfs is less than the estimated 1240 cfs peak discharge of the 100-year flood, the spillway capacity is rated as inadequate.

(2) Considering the rotted condition of the plank sheeting to the right of the spillway wall, further deterioration of the sheeting may cause leakage and the stability of the dam could, in time, be affected.

(3) Brush and small trees on top of the dam crest and at close proximity to the toe indicate that maintenance of the dam is unsatisfactory.

b. Adequacy of Information: The data collected from previously cited dam inspection reports, past performance, visual inspection and computations performed as part of this study are sufficient for the Phase I safety assessment, delineated in sub-paragraph 1., above.

c. Urgency: The recommendations in Paragraph 7.2 should be implemented as soon as practical or as dictated by the recommended additional investigations that follow.

d. Necessity for Further Investigations: In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations will be necessary.

7.2 Recommendations and Remedial Measures.

a. The following investigations and remedial measures are recommended for immediate implementation by the owner.

(1) Increase the spillway capacity to adequately pass the 100-year flood without overtopping the dam.

(2) Remove brush and small trees from the crest of the dam and the trees in the proximity of the toe of the dam.

(3) Periodically inspect the condition of the plank sheeting and monitor conditions at the toe of the dam. Should leakage be observed at the downstream toe, take appropriate remedial measures.

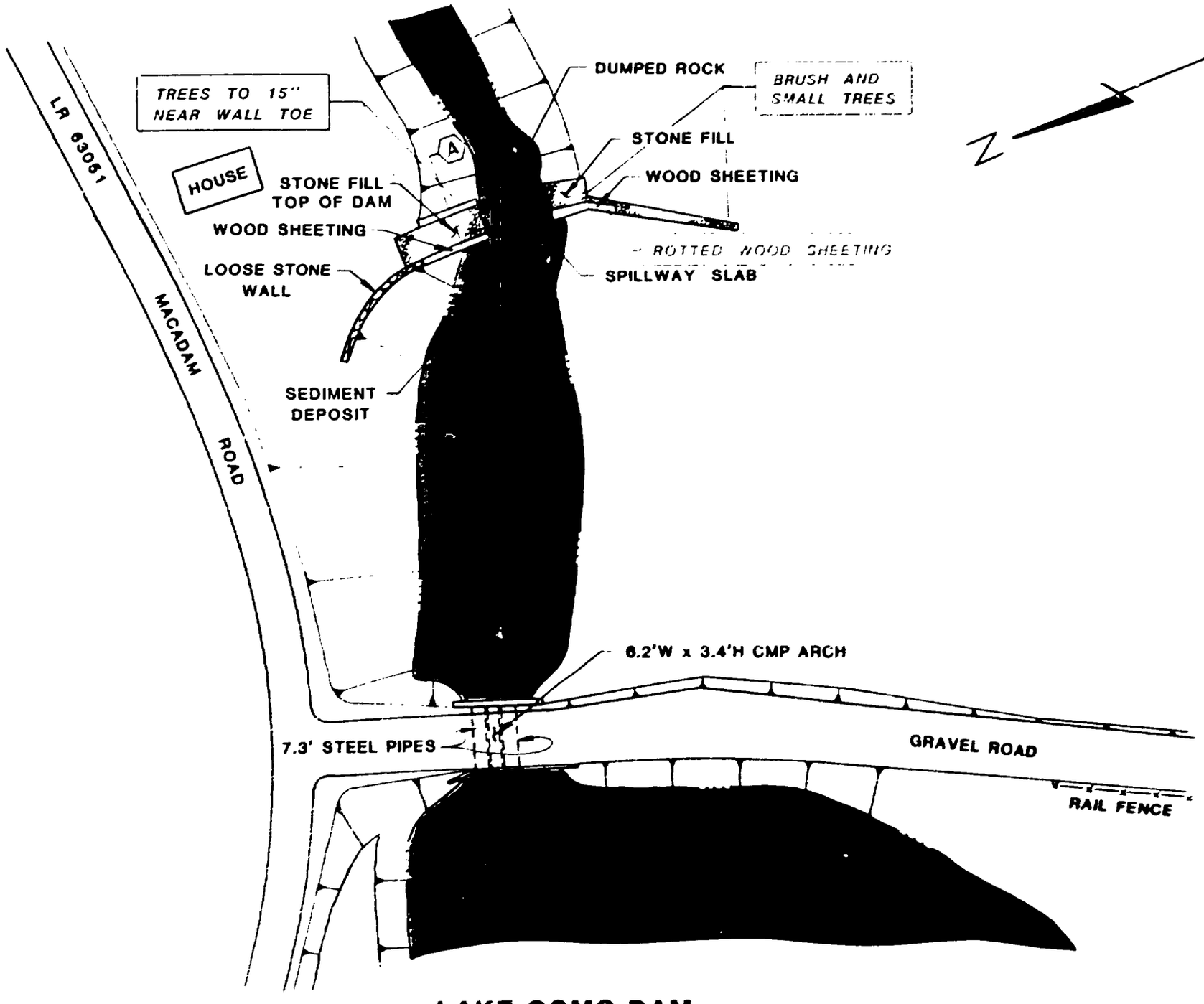
All investigations, monitoring programs and design of remedial measures should be performed by a Professional Engineer, experienced in the design and construction of dams.

b. In addition, it is recommended that the owner take the following precautionary operation and maintenance measures:

(1) After satisfactory implementation of the remedial measures resulting from the recommended additional investigations, institute a formal inspection and maintenance program for the dam. As presently required by the Bureau of Dams and Waterway Management of PENNDER, the program shall include an annual inspection of the dam by a Professional Engineer, experienced in the design and construction of dams. Deficiencies found during annual inspections should be remedied as necessary.

APPENDIX A

VISUAL INSPECTION - CHECKLIST AND FIELD SKETCHES



LAKE COMO DAM

GENERAL PLAN - FIELD INSPECTION NOTES

EXHIBIT A-1

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB LAKE COMO
SHEET NO 1 OF 2
CALCULATED BY RJM DATE 7-21-81
CHECKED BY DATE
SCALE HORZ. 1"=40' VERT. 1"=4'

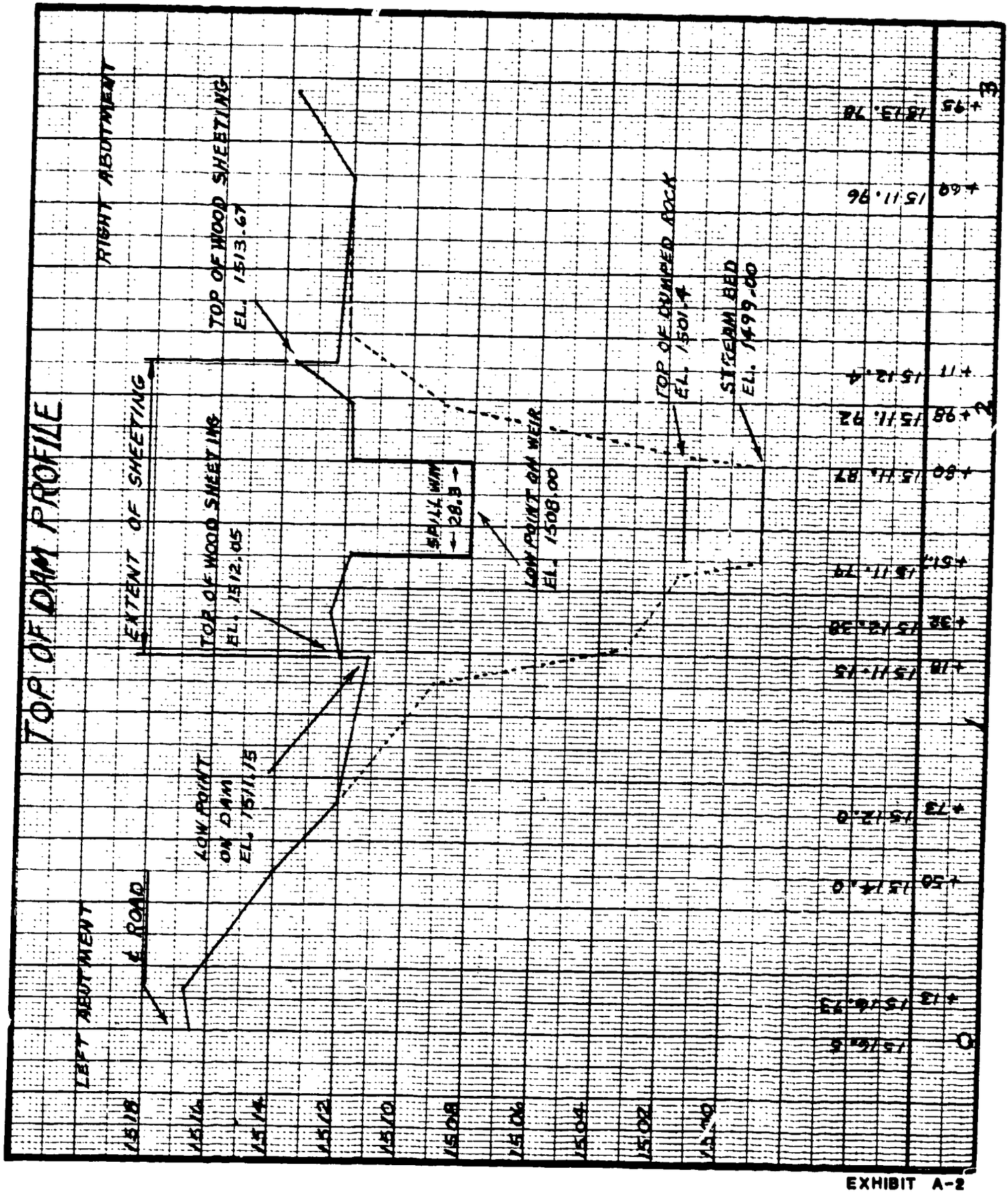


EXHIBIT A-2

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

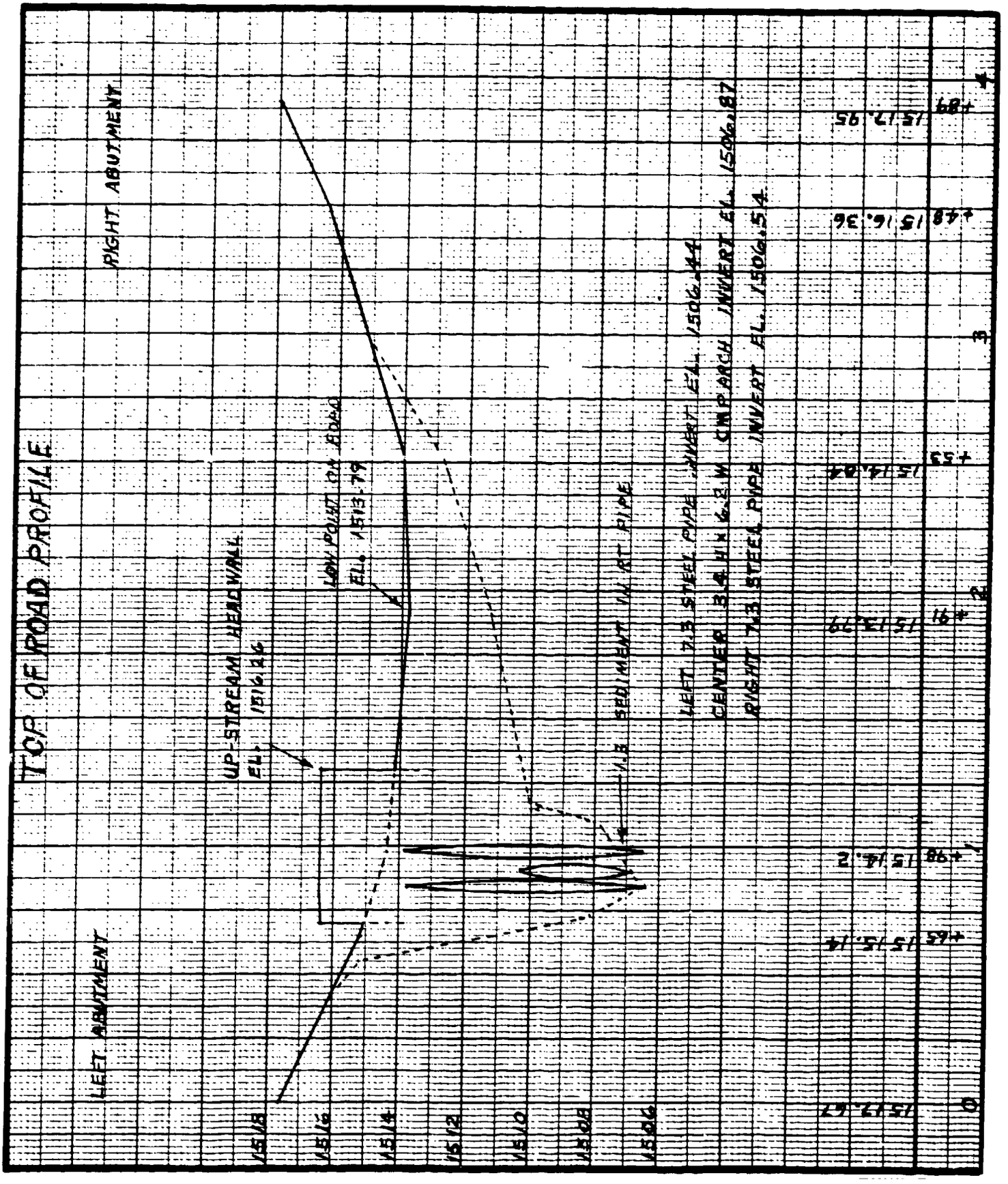
JOB LAKE COMO

SHEET NO 2 OF 2

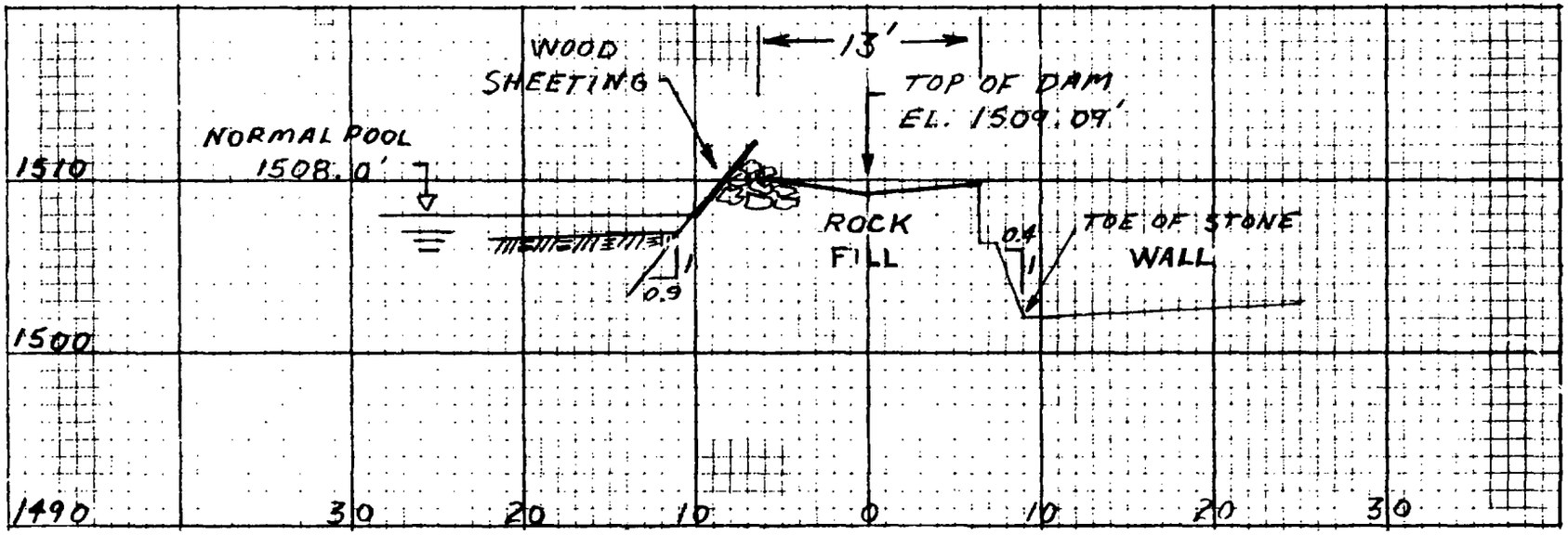
CALCULATED BY RJM DATE 7-21-81

CHECKED BY _____ DATE _____

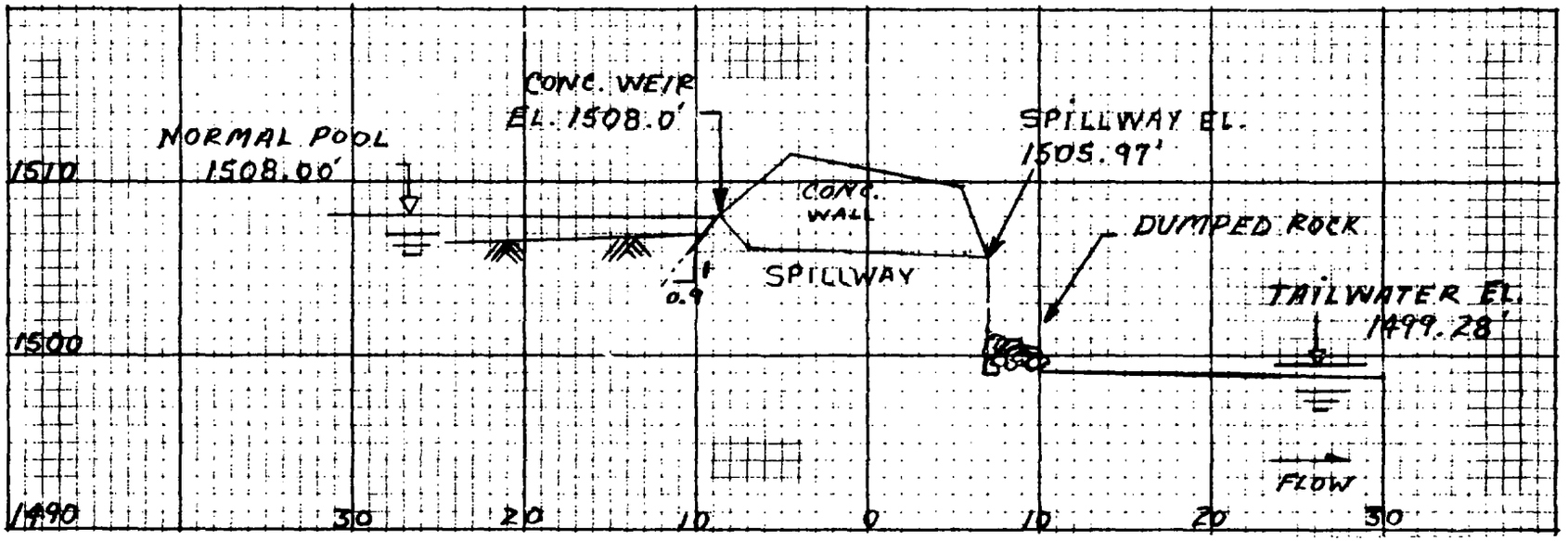
SCALE HORZ. 1" = 50' VERT. 1" = 4'



TYPICAL DAM SECTIONS



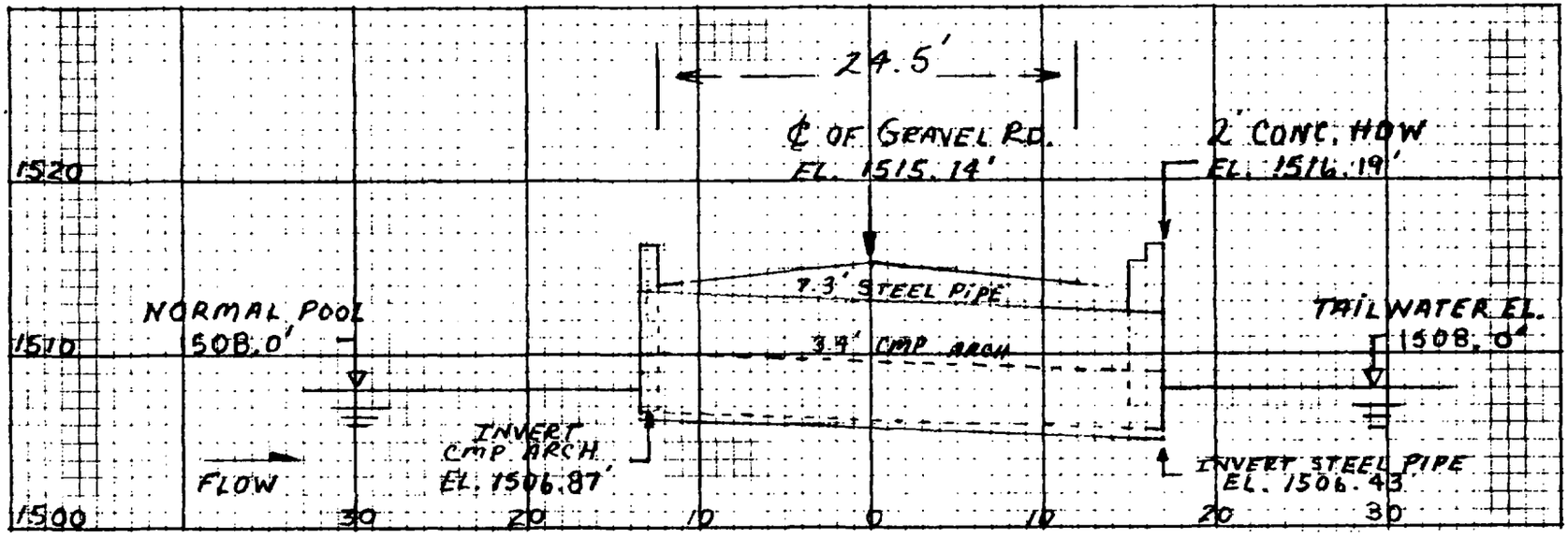
SECTION A



SPILLWAY SECTION

EXHIBIT A-4

TYPICAL DAM SECTIONS



UPSTREAM CULVERT SECTION

EXHIBIT A-6

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Lake Como Dam STATE Pennsylvania COUNTY Wayne

NDI # PA — 00130 PENNDER # 64-016

TYPE OF DAM _____ SIZE Small HAZARD CATEGORY Low

DATE(S) INSPECTION June 24, 1981 WEATHER Clear TEMPERATURE 65°F @ 9:00 a.m.

POOL ELEVATION AT TIME OF INSPECTION 1508.0 M.S.L.

TAILWATER AT TIME OF INSPECTION 1499.3 M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
Gideon Yachin, Engineer	Robert Gilchrist	
James Diaz, Geologist		
Ronald Mather, Surveyor		

RECORDED BY James Diaz

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA-00130
SURFACE CRACKS	None
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal alignment is fair (concave toward upstream). Vertical alignment is uneven and varies about 1 foot.
RIPRAP FAILURES	No riprap. Two overlapping layers of sloping plank sheeting (1 x 12" and 2 x 12") extend about 30 feet from both sides of the spillway. Extending 55 to 60 feet beyond the plank sheeting on both abutments are 3' wide loose stone walls.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Dry and in good condition.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00130
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	None
ANY NOTICEABLE SEEPAGE	None
STAFF GAGE AND RECORDER	None
DRAINS	None
ROCK OUTCROPS	None - Frequent large slabs of sandstone in stream channel and both banks suggest near surface bedrock.
TREES	Brush and small trees in dam. Some large trees to 15" in diameter very close to downstream wall.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00130
INTAKE STRUCTURE	None
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	None
OUTLET STRUCTURE	None
OUTLET CHANNEL	None
GATE(S) AND OPERATIONAL EQUIPMENT	None

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00130
TYPE AND CONDITION	Sharp crested concrete wier (1'-7" with 1 on 1 slopes) and sloping concrete slab with concrete side walls. All in good condition.
APPROACH CHANNEL	Narrow, shallow (1' to 3' deep) fore bay (50'± to 100' wide x 150'± Long) between dam and upstream road culvert serves as spillway approach channel. Sediment deposit 15'± upstream of left spillway wall, creates an island with divided flow at normal pool.
SPILLWAY CHANNEL AND SIDEWALLS	Vertical concrete walls, 13" wide, 3.8' to 5.5' high, in good condition. Concrete spillway slab and concrete weir in good condition.
STILLING BASIN PLUNGE POOL	None. Dumped sandstone boulders below spillway serve as energy dissipator
DISCHARGE CHANNEL	Natural wooded channel.
BRIDGE AND PIERS EMERGENCY GATES	None.

SERVICE SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00130
TYPE AND CONDITION	None
APPROACH CHANNEL	None
OUTLET STRUCTURE	None
DISCHARGE CHANNEL	None

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA-00130
MONUMENTATION SURVEYS	None
OBSERVATION WELLS	None
WEIRS	None
PIEZOMETERS	None
OTHERS	None

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00130
SLOPES: RESERVOIR	Wooded slopes around reservoir vary from 5 to 10 percent. There are no slope conditions that would affect the safety of the dam.
SEDIMENTATION	Slight.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	None. Natural wooded channel with highway culvert about 1500' downstream.
SLOPES: CHANNEL VALLEY	Natural wooded slopes (1V on 1H to 1V on 2H) 10'± high at dam and 30'± high at downstream highway culvert.
APPROXIMATE NUMBER OF HOMES AND POPULATION	Along the first 2000 feet stretch downstream of the dam: One occupied home, 15 feet above the streambed; one unoccupied, 11 feet above the streambed and a Lumber Company storage building, 28 feet above streambed (see Photographs 17,18 and 19, Appendix C).

APPENDIX B

ENGINEERING DATA - CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Lake Como Dam

ITEM	REMARKS	NDI# PA - 00130
PERSONS INTERVIEWED AND TITLE	Robert K. Gilchrist, Owner	
REGIONAL VICINITY MAP	See Exhibit E-1, Appendix E	
CONSTRUCTION HISTORY	Unknown. Constructed prior to 1914. Spillway was reconstructed in 1953.	
AVAILABLE DRAWINGS	See Appendix E	
TYPICAL DAM SECTIONS	For typical sections obtained by survey (6/24/1981), see Appendix A.	
OUTLETS PLAN DETAILS DISCHARGE RATINGS	Not Applicable (no outlet works). Bottom of reservoir for the first 200 feet upstream of the dam varies from 1 to 3 feet below normal pool.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA. 00130
SPILLWAY PLAN SECTION DETAILS	For design of reconstruction, see Appendix E. For surveyed section, see Exhibit A-4, Appendix A.
OPERATING EQUIP- MENT PLANS AND DETAILS	Not applicable (no operating equipment).
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available. For general geologic description of the dam site, see Appendix F.
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None available other than noted. 1952 design criteria for spillway reconstruction was based on 210 csm (cubic feet per second per sq. mile).
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None available

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00130
BORROW SOURCES	Not known.	
POST CONSTRUCTION DAM SURVEYS	None available prior to 1917. For visual appearance of the dam in 1917, 1920, 1930, 1938, 1941 and 1965, see Appendix E. For conditions on 6/24/81, see Appendix A.	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Inspection reports (1917, 1920, 1924, 1930, 1931, 1935, 1938, 1941, 1948, 1952, 1953 and 1965) on file with PennDER.	
HIGH POOL RECORDS	No formal records are available	
MONITORING SYSTEMS	None	
MODIFICATIONS	Spillway reconstructed in 1953 to increase capacity.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00130
PRIOR ACCIDENTS OR FAILURES	Not reported	
MAINTENANCE RECORDS MANUAL	None available	
OPERATION: RECORDS MANUAL	None available	
OPERATIONAL PROCEDURES	Self-regulating.	
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None available	
MISCELLANEOUS	Dam is located 200 feet downstream of the natural outlet of the Lake. Outflow from the Lake is regulated by a culvert at the Lake's outlet.	

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00130
PENNDER ID # 64-16

SIZE OF DRAINAGE AREA: 3.79 square miles

ELEVATION TOP NORMAL POOL: 1508.0 STORAGE CAPACITY: 675 acre-feet

ELEVATION TOP FLOOD CONTROL POOL: NA STORAGE CAPACITY: NA

ELEVATION MAXIMUM DESIGN POOL: 1512.0 STORAGE CAPACITY: Unknown

ELEVATION TOP DAM: 1511.2 STORAGE CAPACITY: 939 acre-feet

SPILLWAY DATA

CREST ELEVATION: 1508.0

TYPE: Sharp crested concrete weir

CREST LENGTH: 28.3 feet (Existing); 30 feet (Design)

CHANNEL LENGTH: 14 feet long concrete apron, downstream of weir.

SPILLOVER LOCATION: Near the middle of the dam.

NUMBER AND TYPE OF GATES: None

OUTLET WORKS N A (No Outlet Works)

TYPE:

LOCATION:

ENTRANCE INVERTS:

EXIT INVERTS:

EMERGENCY DRAWDOWN FACILITIES:

HYDROMETEOROLOGICAL GAGES

TYPE: None

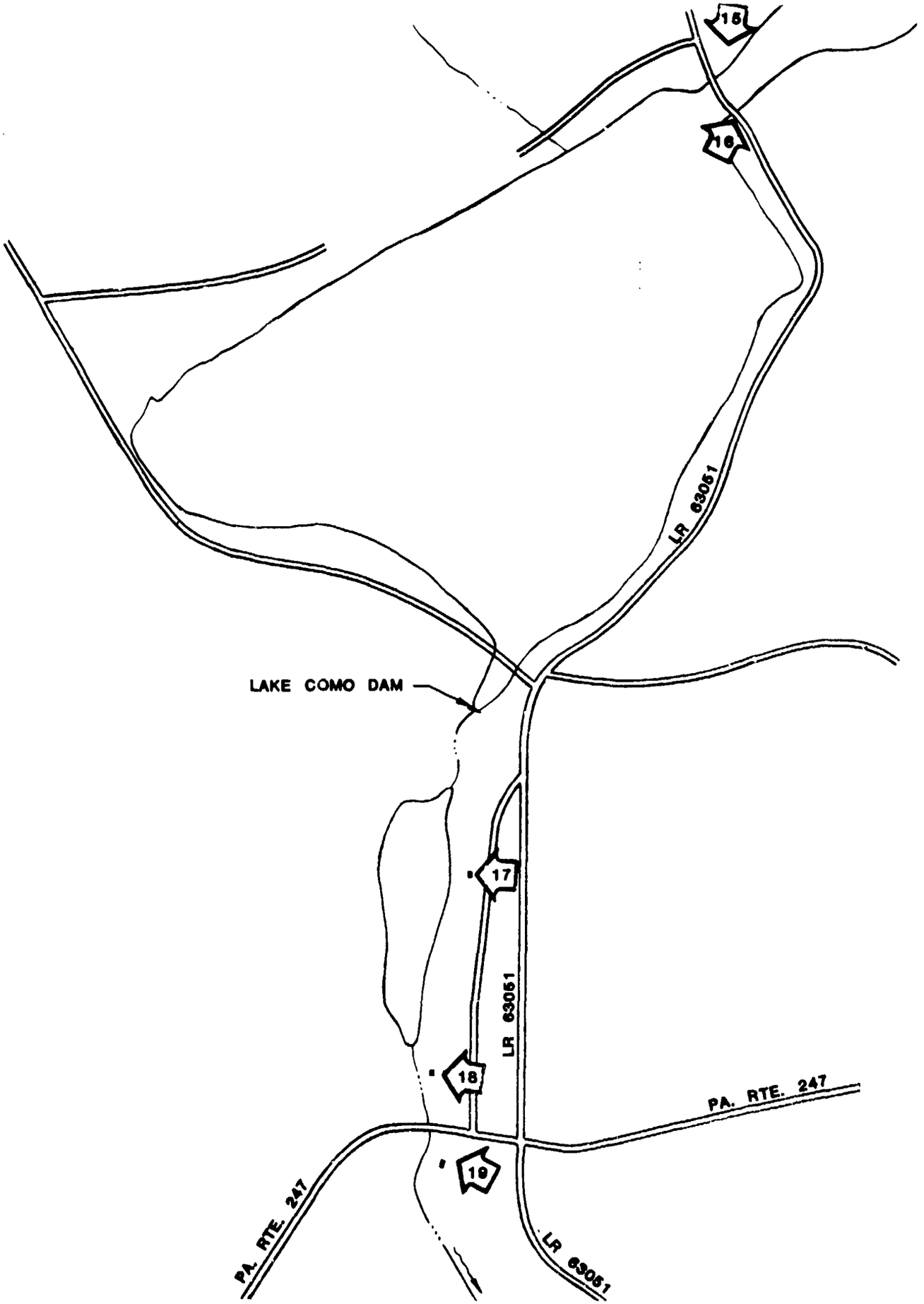
LOCATION: NA

RECORDS: NA

MAXIMUM NON-DAMAGING DISCHARGE: 535 cfs

APPENDIX C

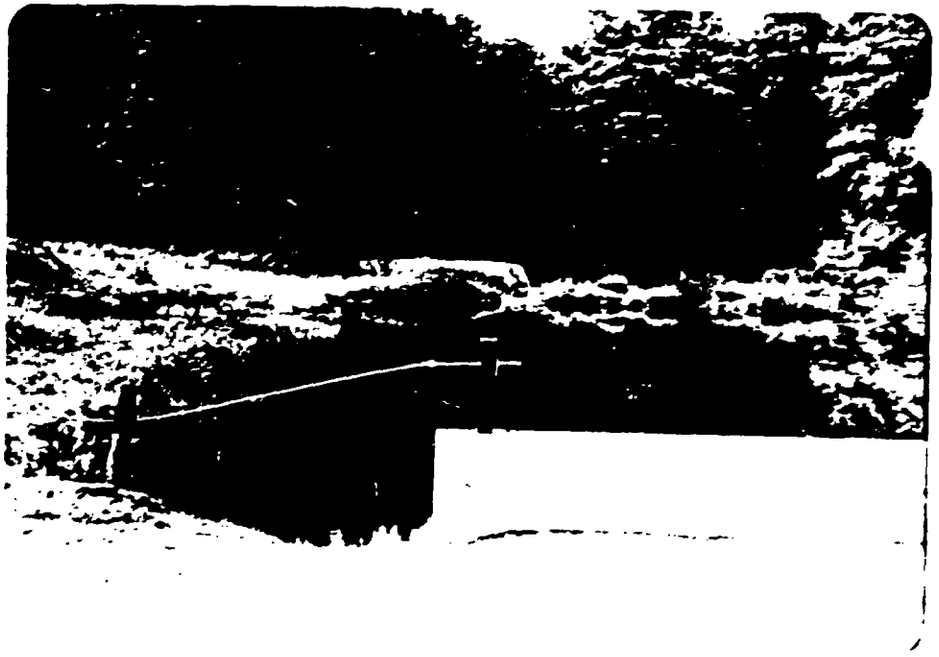
PHOTOGRAPHS



LAKE COMO DAM
DOWNSTREAM PHOTOGRAPHS LOCATION MAP

EXHIBIT C-2

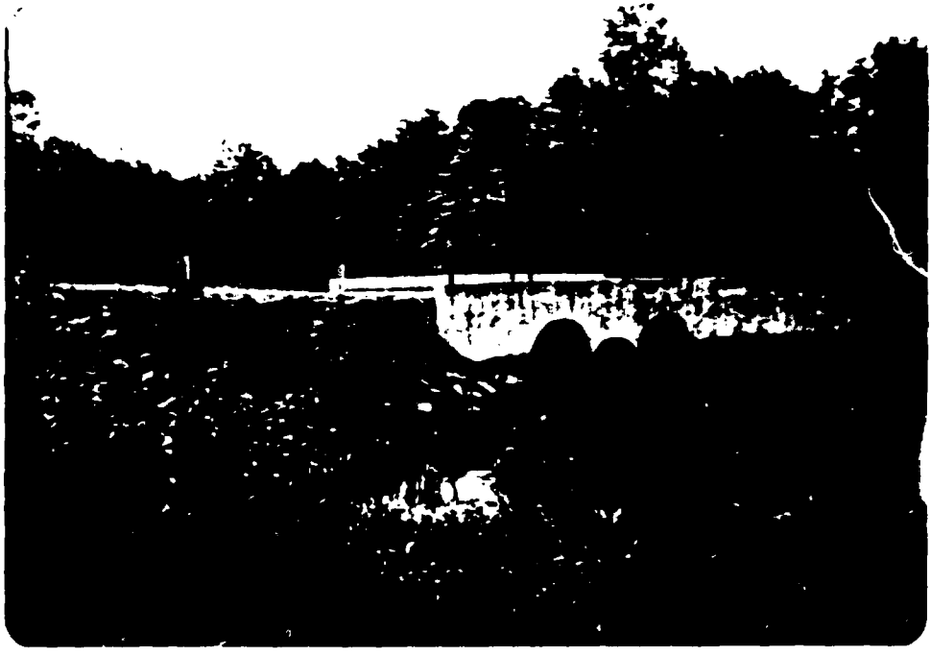
1. AERIAL VIEW(DAM IN BACKGROUND, SEE ARROW)



2. SHEETING, LEFT OF SPILLWAY (VIEW FROM ROAD)

UPSTREAM FACE OF DAM

3. VIEW OF CULVERT, UPSTREAM OF DAM



4. UPSTREAM VIEW OF CULVERT (SEE PHOTO 1)

5. UPSTREAM SHEETING & RIGHT SPILLWAY WALL

6 LEFT SPILLWAY WALL (SHOWING END OF APRON)

7. SHARP CRESTED CONCRETE WEIR
(SHOWING RIPRAP IN APPROACH CHANNEL)

8. FROM RIGHT ABUTMENT

10. UPSTREAM VIEW

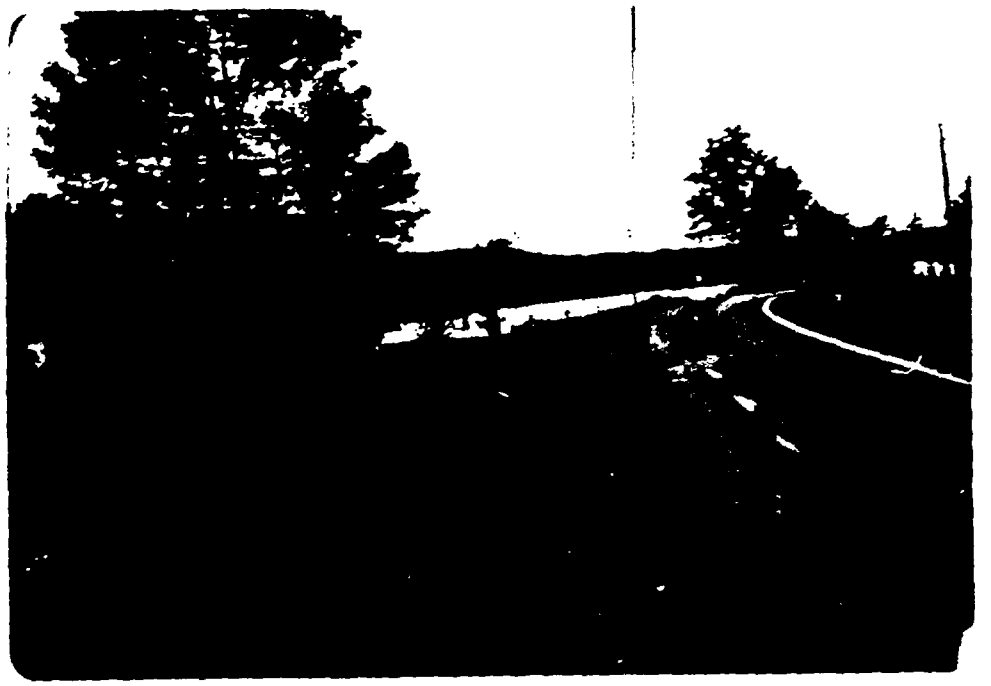
9. SHOWING DUMPED ROCK PROTECTION IN PLUNGE POOL

UPSTREAM VIEW OF SPILLWAY

11. VIEW FROM LEFT ABUTMENT

DOWNSTREAM FACE OF DAM

12. DOWNSTREAM FACE OF DAM, RIGHT ABUTMENT



13. ROAD ABOVE LEFT ABUTMENT, LOOKING UPSTREAM OF DAM ON 1st LAKE CROSSING

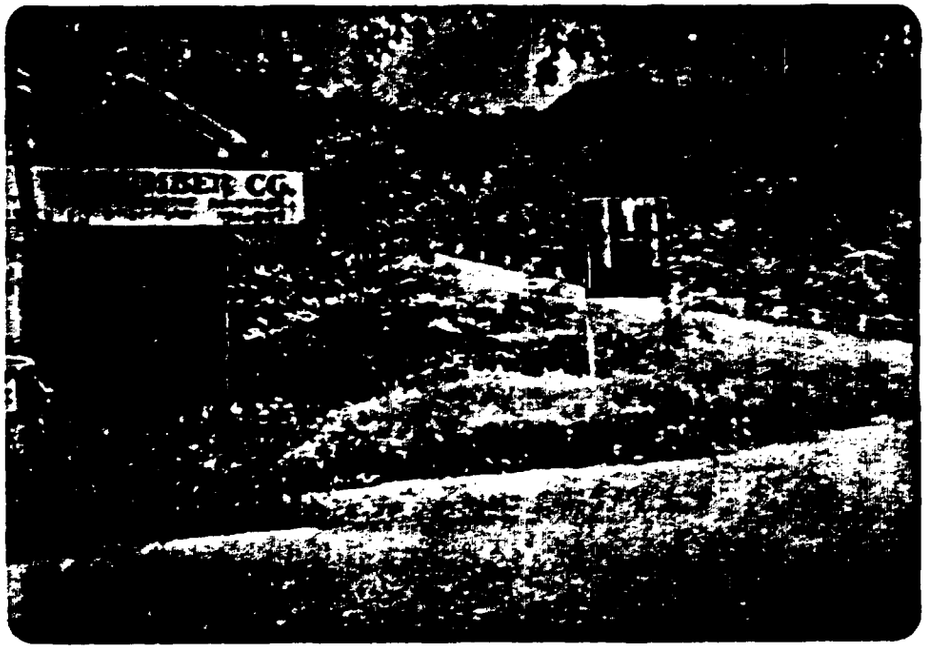
14. RIGHT LAKE SHORE, UPSTREAM OF 1st CROSSING

15. UPSTREAM VIEW OF CULVERT (2nd CROSSING)

16. VIEW OF LAKE (UPSTREAM OF 2nd CROSSING)

17. DOWNSTREAM HAZARD (STREAM BEHIND HOME)
PARSONAGE HOME, 800' DOWNSTREAM OF DAM

18. 1 STORY HOUSE, PRESENTLY VACANT
(STREAM 40' IN BACK OF HOUSE)



19. 2 STORY LUMBER CO. STORAGE (1600' DOWNSTREAM)

APPENDIX D

HYDROLOGY AND HYDRAULICS

GENERAL DATA - LAKE COMO DAM

RIVER BASIN	DELAWARE
STREAM NAME	KINNEYVILLE CREEK
NDI I.D. NO	PA-130
DER I.D. NO	64-016
OWNER	R. GILCHRIST
LOCATION	PRESTON TWP.
CO.	WAYNE
QUAD.	LAKE COMO
LAT.	41°-50'-58"
LONG.	75°-20'-34"
SIZE	Small
HAZARD	Significant
DRAINAGE AREA	3.79 Sq. Miles

Watershed Features Road crossing and culvert upstream of dam restrict flow and control the outflow from the reservoir. Consequently, spillway discharges at the damsite are controlled by the upstream culvert (see Exhibit E-1 and photographs 1 thru 4, Appendix C).

EFFECT OF UPSTREAM CULVERT ON RESERVOIR SPILLWAY DISCHARGES

a. From Sheet D-3
At normal pool Level the reservoir storage is 675 ac-ft
At the level of the low point on the road, over the upstream culvert (Elev. 1513.83) the storage capacity of the reservoir is 1168 ac-ft

b. From Sheets D-4 & D-10

The present capacity of the spillway is 535 cfs

c. From Sheet D-11

The estimated 100-year peak flood inflow is 1240 cfs.

The effect of storage, upstream of the culvert on spillway discharges is estimated as follows:

Reference: Urban hydrology for small watersheds, Technical Release No. 55, Soil Conservation Service (SCS), 1975

Dimensionless relationship between V_s/V_r and Q_o/Q_i are presented on sheet D-12.

V_s = storage, V_r = Volume of storm runoff
Q_o = Peak outflow from reservoir
Q_i = Peak inflow into reservoir

If it is desired to Limit the outflow to 535 cfs
$Q_o/Q_i = 535/1240 = 0.43$. From Sheet D-12 $V_s/V_r = 0.325$
$V_s = 1168 - 675 = 493$ ac-ft (between normal pool and El. 1513.83).
Therefore, $V_r = V_s/0.325 = 493/0.325 = 1517$ ac-ft, or the equivalent of $1517/(3.79 \times 640) = 0.625$' (7.5" of runoff)

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB
SHEET NO. OF
CALCULATED BY GY DATE 7/30/1981
CHECKED BY DATE
LAKE COMO DAM; PA-00130

RESERVOIR STORAGE DATA

Given storage at normal pool 675 ac-ft (From DER files)

ELEVATION	AREA (ACRES)	(ΔV)**	STORAGE (AC-FT)	
1482.70*	0		0	
1508.00	80		675	Normal Pool
1511.20	65	(264)	939	Top of dam
1511.64	86	(38)	977	
1511.74	86	(9)	986	
1513.83	88	(182)	1168	Top of upstream Rd.
1516.11	95	(209)	1377	

Note: Storage capacity at EL 1514.8 is 1257 ac-ft
Storage Capacity at EL 1506.9 is 646
Loss of Storage due to breach ⟶ 611 ac-ft

* $h = \frac{3 \times 675}{80} = 25.30$ feet; Zero storage = 1508 − 25.3 = 1482.7

** $\Delta V_{12} = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$

Where h is the incremental rise between elevations 1 & 2.
A_1 & A_2 are the areas at elevation 1 & 2

Ref. Conic Method for Reservoir Volume; Flood Hydrograph Package (HEC-1), September 1978

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB _____
SHEET NO. _____ OF _____
CALCULATED BY GY DATE 7/30/1981
CHECKED BY _____ DATE _____

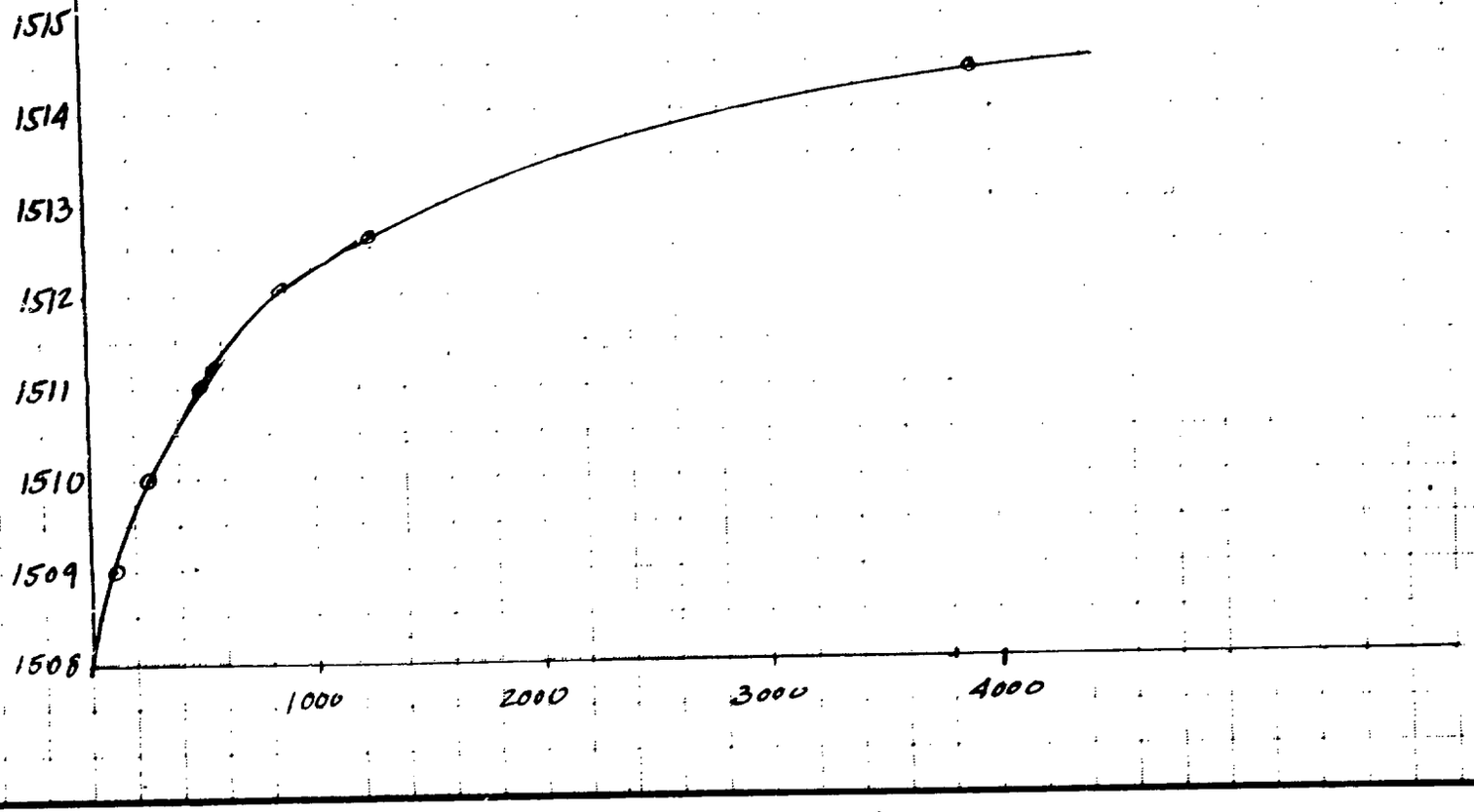
LAKE COMO DAM, PA-00130

D-4

DISCHARGE OVER DAM (INCL. SPILLWAY)

RESERVOIR W.S. EL.	DISCHARGE (cfs) SPILLWAY	DAM	TOTAL
1508.00	0	—	0
1509.00	93.4	—	93.4
1510.00	264	—	264
1511.00	485	—	485
1511.20	535	—	535
1512.08	770	75	845
1512.64	933	319	1252
1514.42	1519	2426	3945

Reference:
See Sheets D-5 & D-6



GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB _____

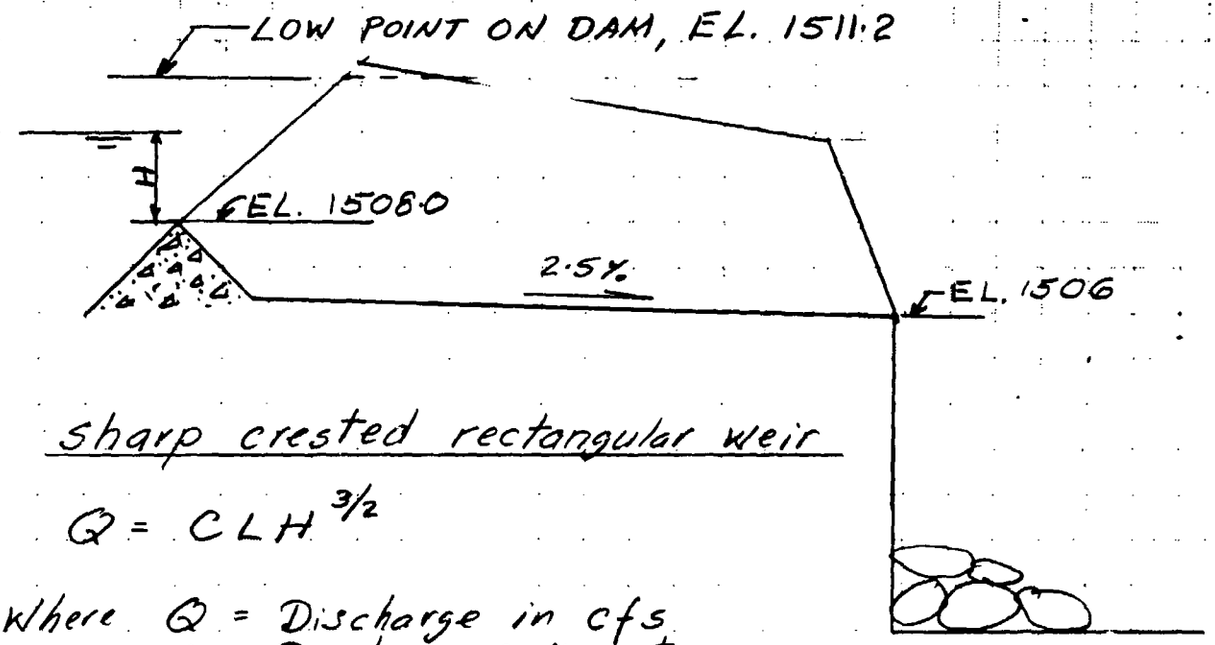
SHEET NO. _____ OF _____

CALCULATED BY GY DATE 7/30/1981

CHECKED BY _____ DATE _____

LAKE COMO DAM; PA-00130

SPILLWAY RATING CURVE



Sharp crested rectangular weir

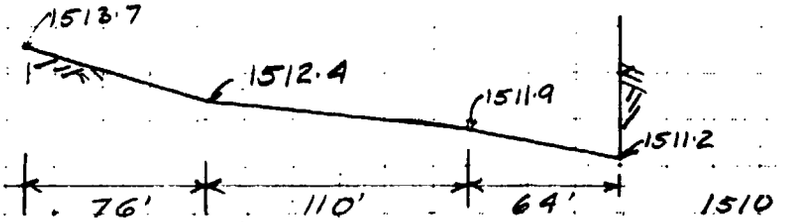
$Q = C L H^{3/2}$

Where Q = Discharge in cfs
C = Discharge Coefficient = 3.3
L = Crest Length = 28.3'
H = Head over crest, feet

H ft	$Q = 93.39 \times H^{3/2}$ cfs	
1	93.4	
2	264	
3	485	
3.2	535	← Top of dam
4.08	770	overtopping condition
4.64	933	" "
6.42	1519	" "

NOTE: For the given apron slope the crest of the weir will not be affected by tailwater for the above indicated discharge rates.

DAM OVERTOPPING ANALYSIS



Reference: King's Handbook of Hydraulics

Dc	a (ft^2)	T (ft)	$Dm = a/T$	$Q = a\sqrt{gDm}$	$Hm = Dc + \frac{Dm}{2}$	W.S. El ft *
0.7	22.4	64	0.35	752	0.88	1512.08
1.2	81.9	174	0.47	318.8	1.44	1512.64
2.5	357.5	250	1.43	2425.9	3.22	1514.42

Flow at "critical depth" conditions over the crest

Dc is the critical depth, in feet
a is the cross sectional flow area at given Dc (ft^2)
T is the top width for given Dc (ft)
Dm is the "mean depth" = a/T
g is the gravitational acceleration 32.2 ft/sec^2
Hm is the head over the low point of dam for given Dc

* Reservoir W.S. El = El. 1511.2 + Hm

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

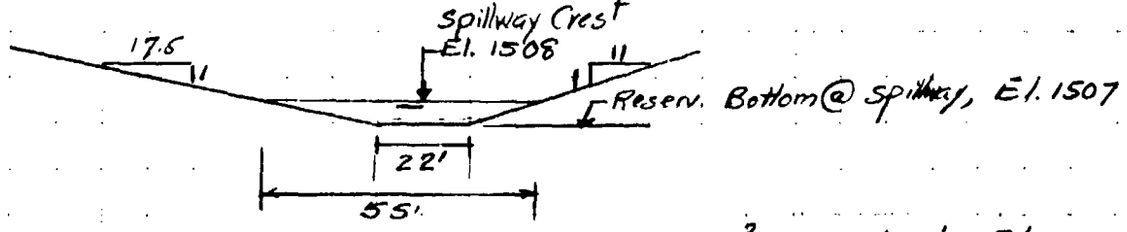
JOB
SHEET NO. OF
CALCULATED BY GY DATE 7/30/1981
CHECKED BY DATE
LAKE COMO DAM; PA-00130

RATING CURVE FOR UPSTREAM CULVERT

The flow at the damsite is governed by the capacity of the upstream culvert, prior to the overtopping of the road. When the road overtops, the discharge at the damsite is controlled by the spillway capacity (see Exhibits A-1, A-3 and A-5, Appendix A and photographs 1, 3 & 4, Appendix C).

The low point on the road crossing is at elevation 1513.8 (see Exhibit A-3). Consequently, when the inflow into the reservoir exceeds the capacity of the culvert, flow at the damsite is controlled by the culvert capacity until the reservoir water surface, upstream of the culvert, reaches elevation 1513.8. Tailwater at the culvert's outlet is determined by adding to the velocity head (of the flow between the culvert outlet and the spillway) to the water surface elevation at the damsite.

TYPICAL FOREBAY SECTION



W.S. ELEV. AT SPILLWAY *	AREA ft²	DISCHARGE cfs *	APPR. VEL. V (ft/sec)	$V^2/2g$	Tailwater Elev. at Culvert
1509	101	93.4	0.925	0.013	1509.01
1510	194	264	1.359	0.029	1510.03
1511	316	485	1.535	0.037	1511.04
1511.2	343.8	535	1.556	0.038	1511.24
1512.08	479.5	845	1.762	0.048	1512.13
1512.64	577.4	1252	2.168	0.073	1512.71
1514.42	947.8	3945	4.162	0.269	1514.69

* From Spillway rating curve

$V = \frac{\text{DISCHARGE}}{\text{AREA}}$

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB _____
SHEET NO. _____ OF _____
CALCULATED BY GY DATE 7/30/1981
CHECKED BY _____ DATE _____
LAKE COMO DAM; PA-00130

UPSTREAM CULVERT RATING CURVE

Use Invert at outlet, El. 1506.5' and start rating curve when the tailwater controls the flow through the culvert (assume at, or above elevation 1511.04).

For each of the 7.3 feet diameter steel pipe the discharge controlled by the outlet can be expressed by the following relationship

$$H = \left[\frac{2.5204\,(1+ke)}{D^4} + \frac{466.18\,n^2 L}{D^{16/3}}\right] \times \left(\frac{Q}{10}\right)^2$$

Reference: Handbook of concrete Culvert Pipe Hydraulics
Portland Cement Association, 1964

Where ke is the entrance head less coefficient
D is the diameter of culvert (feet)
n is the roughness coefficient
L is the length of culvert (feet)
Q is the discharge in cfs
H is the required head (feet)

For $ke = 0.5$, $D = 7.3'$ $n = 0.012$ & $L = 30'$

$$H = 0.00138\left(\frac{Q}{10}\right)^2 \quad \text{and} \quad Q = \frac{10}{\sqrt{0.00138}} \times \sqrt{H} = 269.2\sqrt{H}$$

H (ft)	$Q = 269.2\sqrt{H}$ (cfs)	2×Q cfs	Q_{arch}* cfs	Total cfs
0.5	190	380	65	445
1.0	269	538	90	628
1.5	330	660	120	780
2.0	380	760	130	890
2.5	426	852	150	1002
3.0	466	932	160	1092
3.5	504	1008	170	1178

* From attached curve (Bureau of Public Roads).

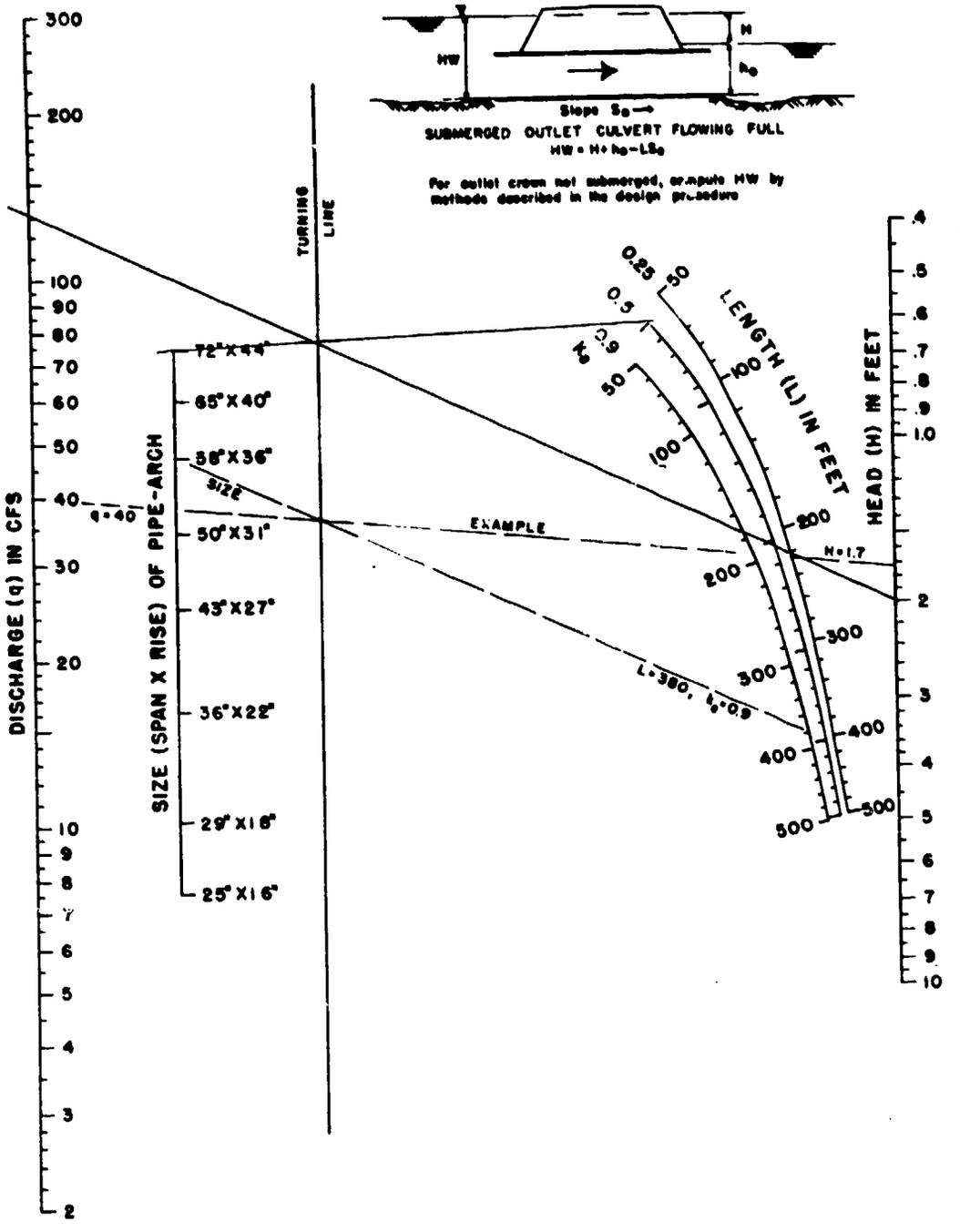
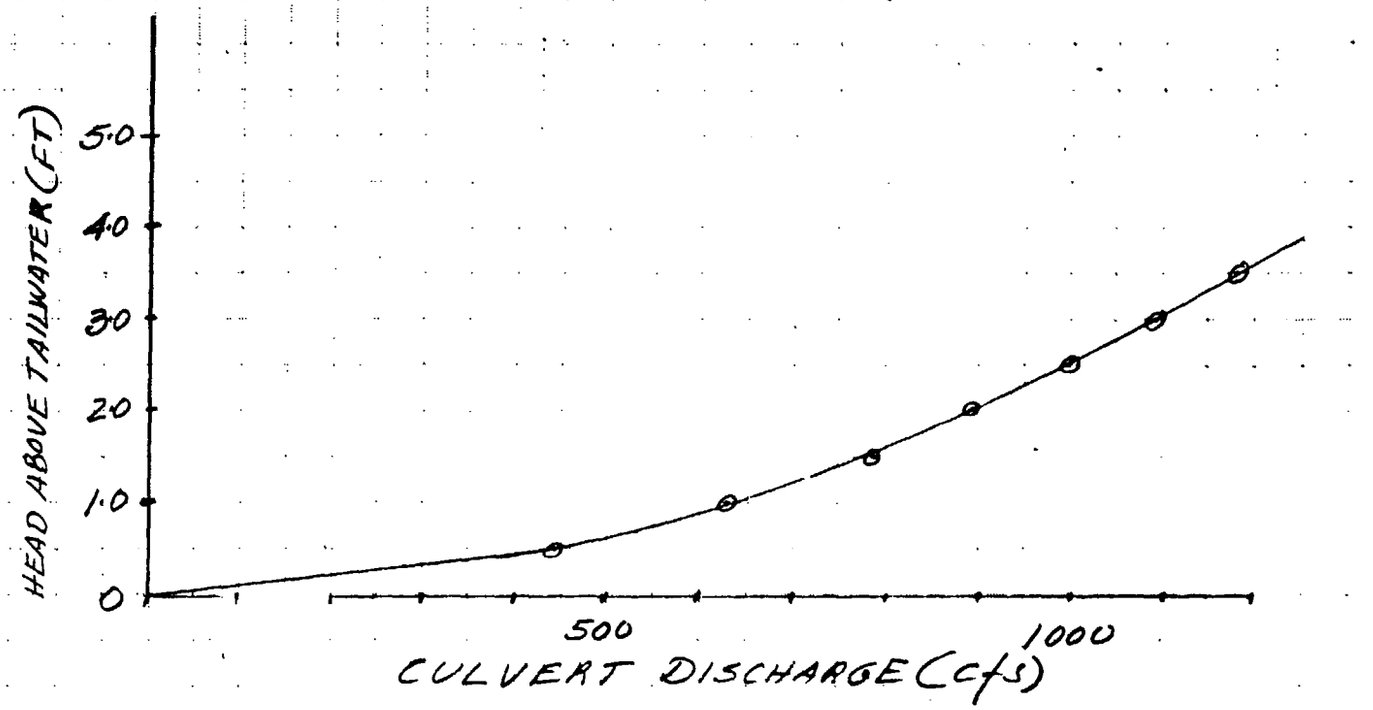


Exhibit 14.15. Head for standard C. M. pipe-arch culverts flowing full n = 0.024.

UPSTREAM CULVERT RATING CURVE (CONT.)



SPILLWAY DISCHARGE CFS	TAILWATER ELEVATION AT CULVERT	HEAD OVER TAILWATER FEET	W.S. ELEV UPSTREAM OF CULVERT
485	1511.04	0.60	1511.64
535	1511.24	0.70	1511.94
845	1512.13	1.70	1513.83 ← Begin road
1252	1512.71	3.40	1516.11* overtopping

* Correction for overtopping: When the discharge at the spillway is 1252 cfs, tailwater at culvert is at El. 1512.71. Assume W.S. Elev. 1514.81, upstream of road. Discharge over road is 345 cfs (computations not presented). Head over culvert (1514.81 − 1512.71 = 2.1') 2.1' flow through culvert 900 cfs. Total flow = 900 + 345 = 1245 cfs, say 1252 cfs. Corrected W.S. Elev for Q = 1252 is 1514.8

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB LAKE COMO DAM
SHEET NO ____ OF ____
CALCULATED BY JR DATE 7/81
CHECKED BY ____ DATE ____
LAKE COMO DAM; PA-00130

DETERMINE 100 YR. FLOOD

REF. 1) REGIONAL FREQUENCY STUDY, UPPER DELAWARE AND HUDSON RIVER BASINS" NEW YORK DIST. C.O.E. 1974
2) CoE. MEMO 4/22/81

$$\text{Log}(Q_m) = C_m + 0.87 \text{ Log}(A)$$

$A = 3.79 \text{ mi}^2$

$C_m = 1.8$ (From F16.2 of Ref.)

$$\text{Log}(Q_m) = 1.8 + 0.87 \text{ Log}(3.79) = 2.30$$

$$S = C_s - 0.05 \text{ Log}(A)$$

$C_s = 0.35$ (From F16.3 of Ref.)

$$S = 0.35 - 0.05 \text{ Log}(3.79) = 0.32$$

$$\text{Log}(Q_p) = \text{Log}(Q_m) + K_{pg} S$$

$p = 100 \text{ yr.}$

$g = 0.2$

$K_{pg} = 2.48$ (From F16.5 of Ref.)

$$\text{Log}(Q_{100}) = 2.30 + 2.48(0.32) = 3.0936$$

$$Q_{100} = \underline{\underline{1240 \text{ cfs}}}$$

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB _____

SHEET NO _____ OF _____

CALCULATED BY GY DATE 7/30/1981

CHECKED BY _____ DATE _____

LAKE COMO DAM; PA-00130

Ref: TR #55 - Urban Hydrology for Small Watersheds, SCS 1975.

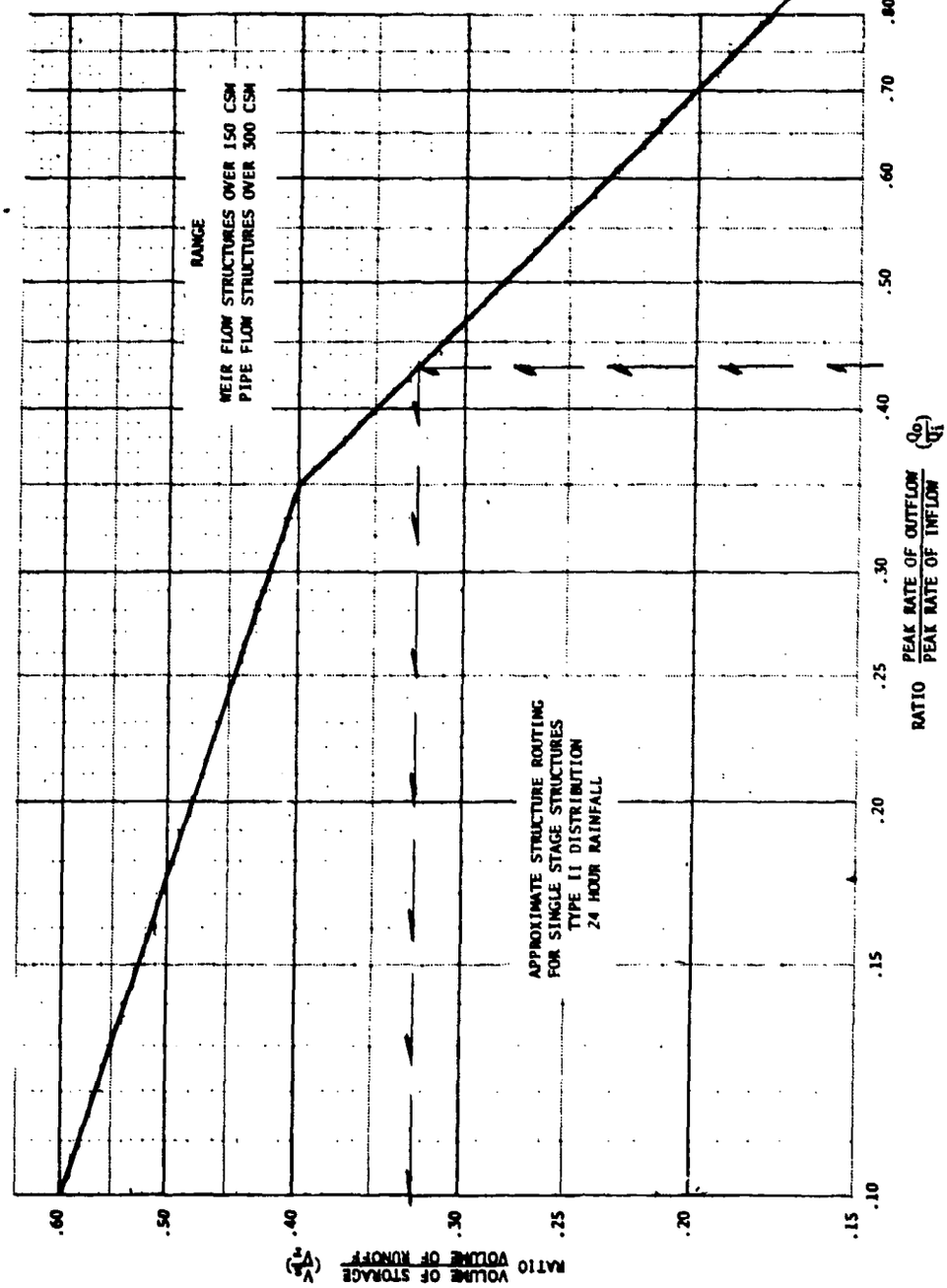
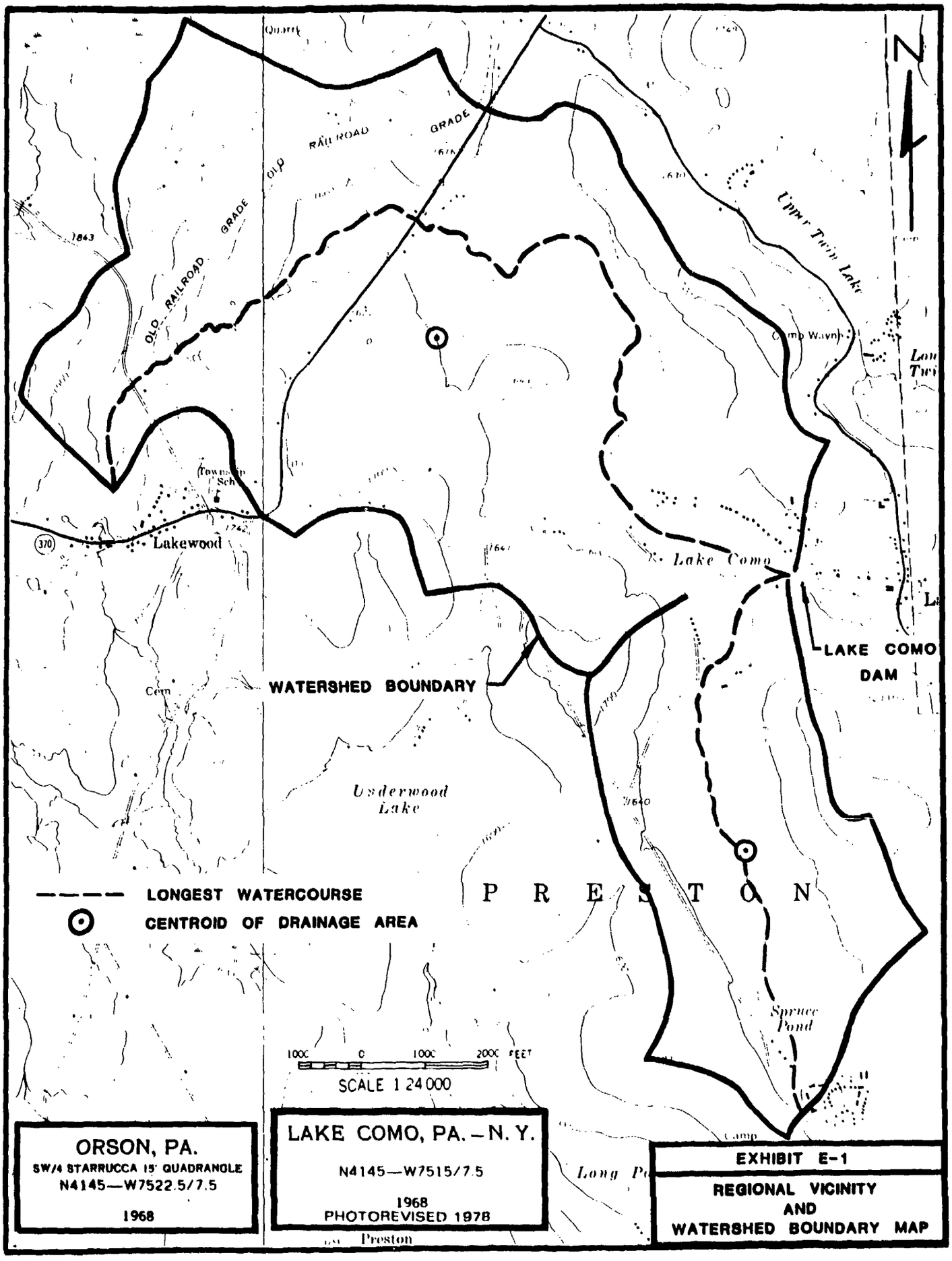
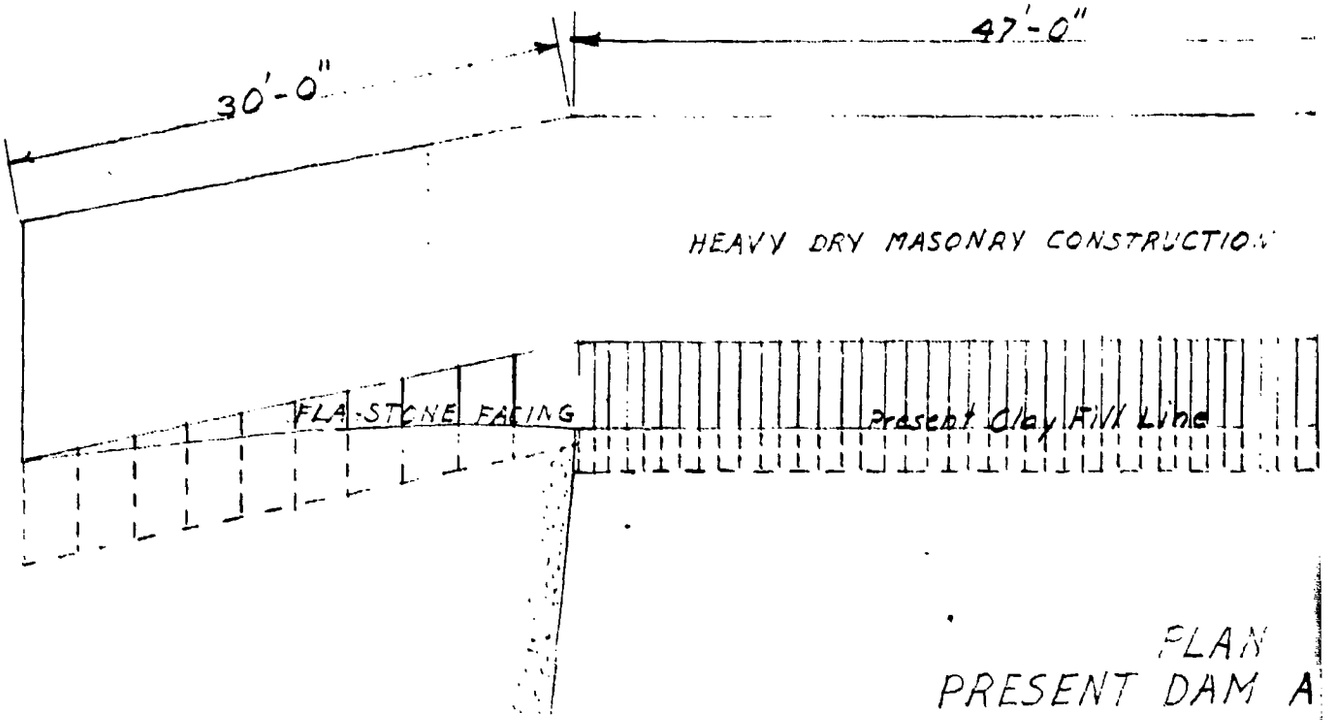


Figure 7-2.--Approximate single-stage structure routing for weir flow structures over 150 csm release rate and pipe flow structures over 300 csm release rate.

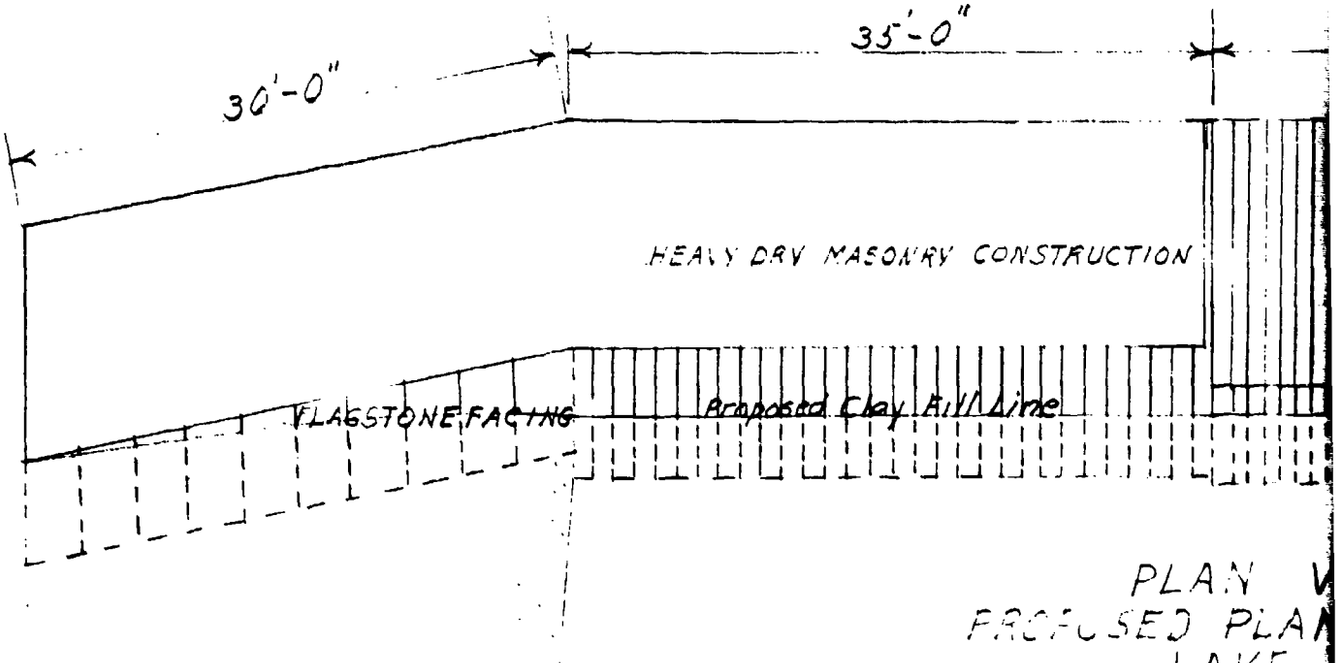
APPENDIX E

EXHIBITS


N
OLD RAILROAD GRADE
OLD RAILROAD GRADE
Upper Twin Lake
Camp Wayne
Lower Twin
Lake Como
LAKE COMO DAM
Lakewood
370
WATERSHED BOUNDARY
Underwood Lake
Spruce Pond
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
P R E S T O N
1000 0 1000 2000 FEET
SCALE 1 24 000
ORSON, PA.
SW/4 STARRUCCA 15' QUADRANGLE
N4145—W7522.5/7.5
1968
LAKE COMO, PA.–N.Y.
N4145—W7515/7.5
1968
PHOTOREVISED 1978
EXHIBIT E-1
REGIONAL VICINITY AND WATERSHED BOUNDARY MAP

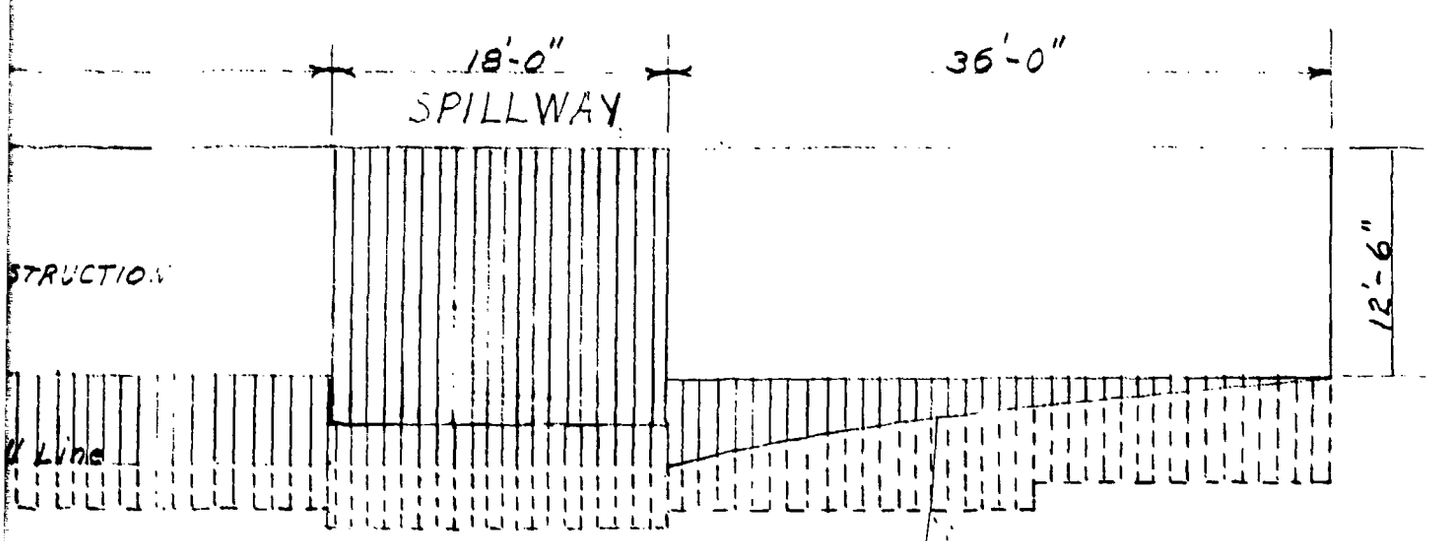


PLAN
PRESENT DAM A

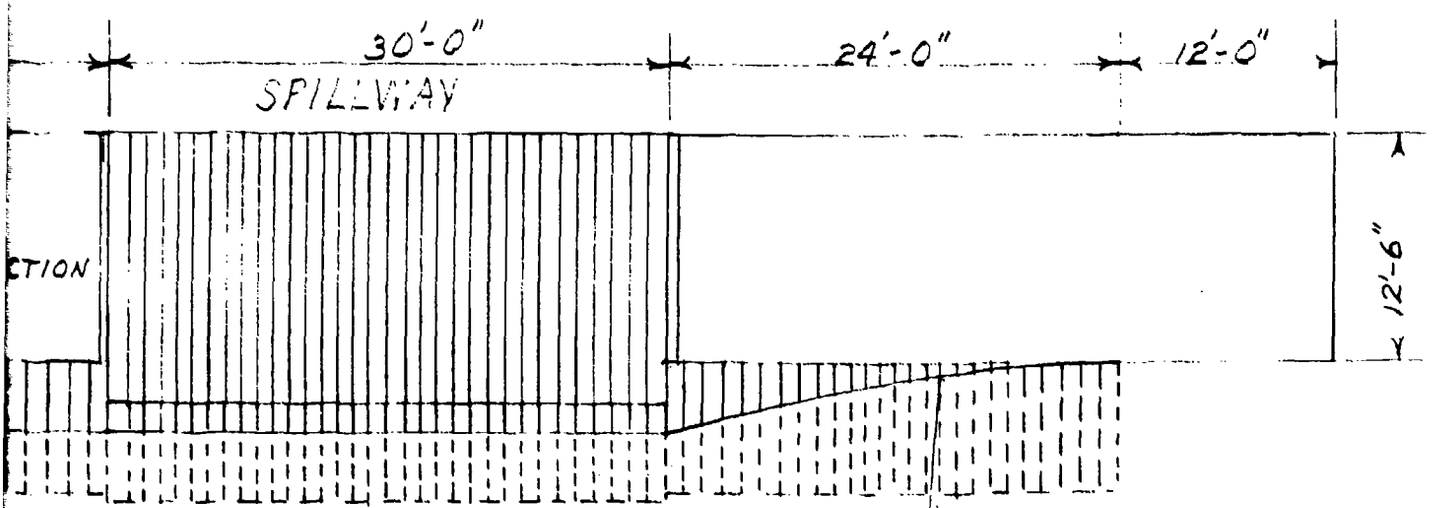


PLAN
PROPOSED PLA
LAKE

SCA



PLAN VIEW
T DAM AT LAKE COMO



PLAN VIEW
SED PLAN FOR DAM AT
LAKE COMO

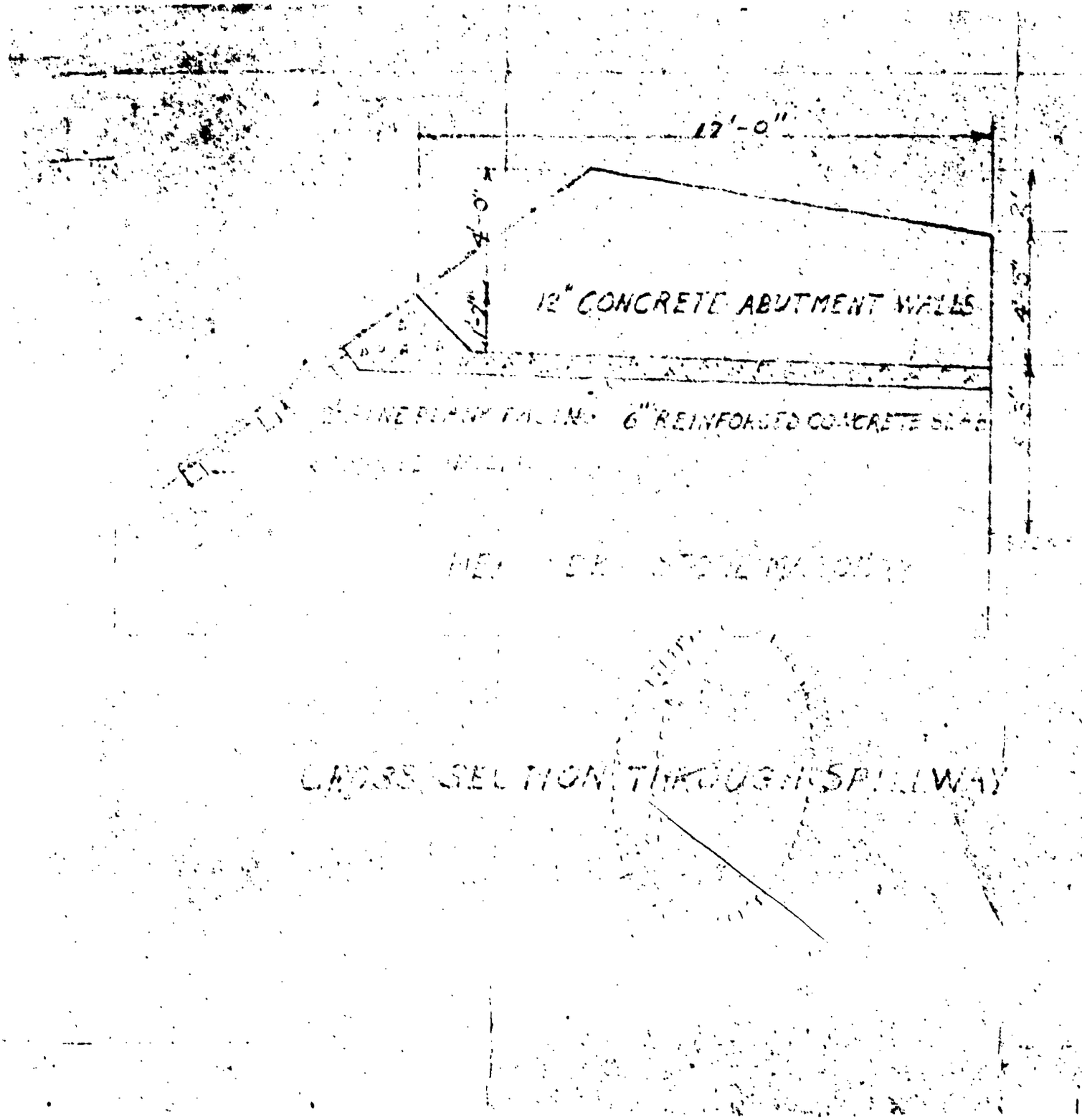
SCALE 1"=10'

PROPOSED DAM REPAIR
LAKE COMO, PENNSYLVANIA

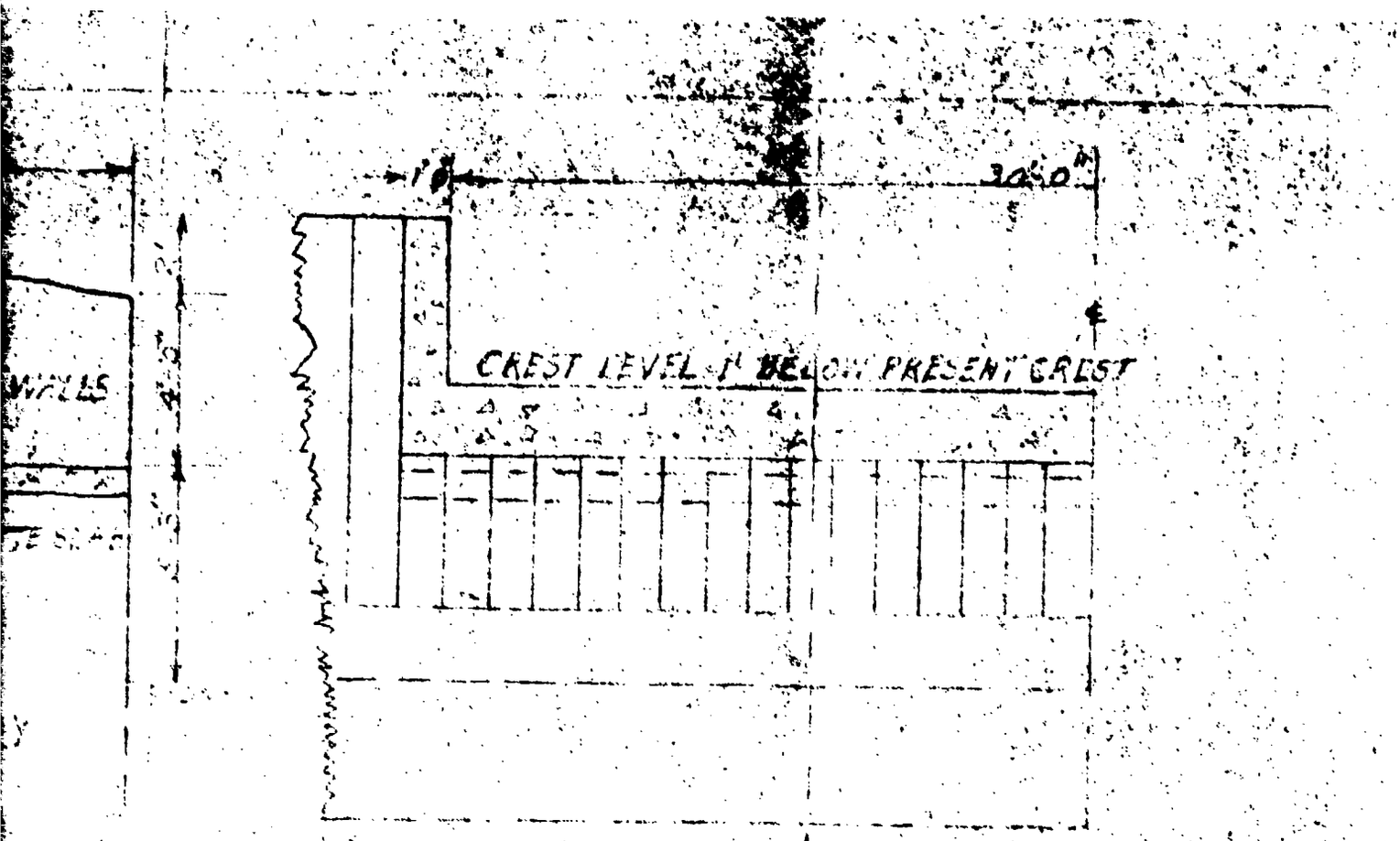
Prepared By: CARL H KINDIG
Date: Aug. 18, 1952 PENNA. P.E. 7799

EXHIBIT E-2

2



CROSS SECTION THROUGH SPILLWAY



SPILLWAY SECTION

REVISED SPILLWAY PLAN
DAM AT LAKE COMO, PA.
Scale 1"=4' Oct. 6, 1952
CARL H. MINDE P.E. 7797

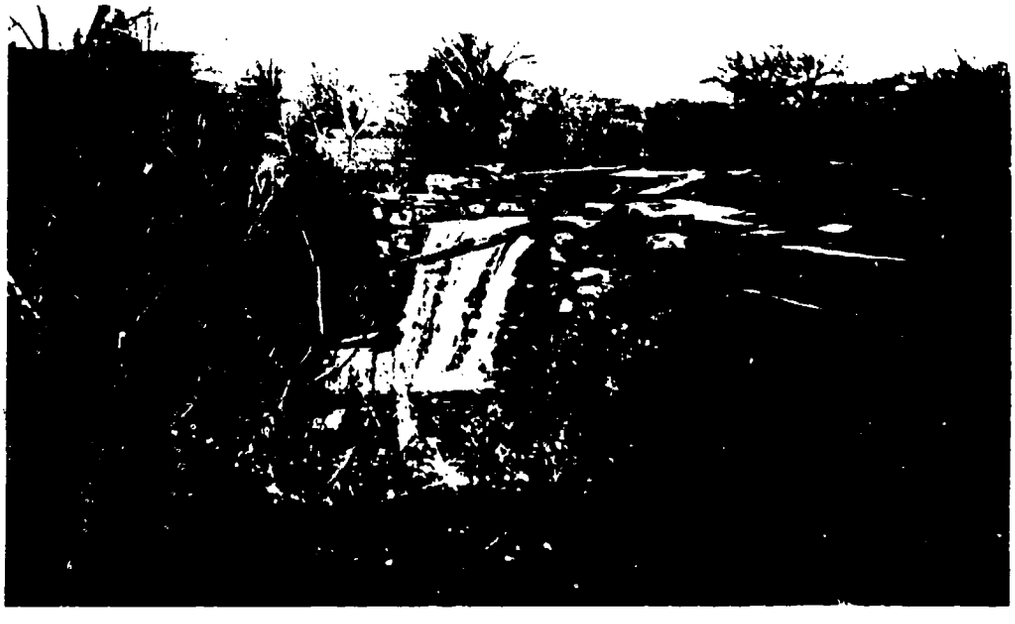
EXHIBIT E-8

UPSTREAM FACE, SHOWING 2" PLANK SHEETING

SPILLWAY (CREST LENGTH 18.3'); NOTE TOP OF
UPSTREAM SHEETING IS ABOVE CREST OF DAM

VIEW OF DAM (MAY, 1917)

EXHIBIT E-4



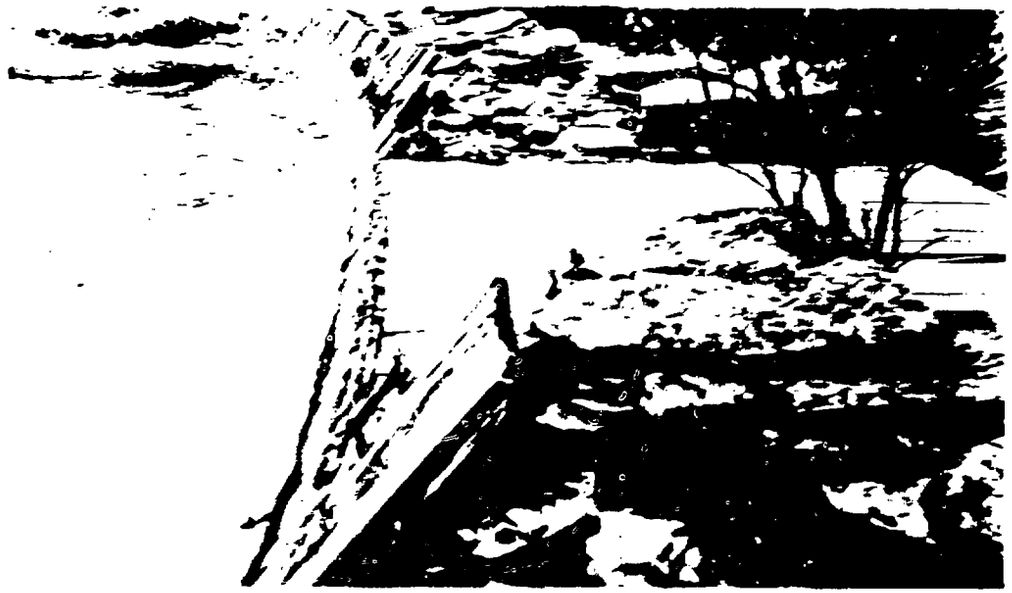
DOWNSTREAM FACE OF DAM (MAY, 1920)

UPSTREAM FACE OF DAM (JUNE, 1930)

UPSTREAM VIEW OF LAKE CROSSING (1930)
BRIDGE IS 150' UPSTREAM OF DAM

SEPTEMBER, 1938

NOTE POSITION OF NORMAL
POOL (1938 & 1941)



OCTOBER, 1941

UPSTREAM FACE OF DAM

EXHIBIT E-6

UPSTREAM FACE

DOWNSTREAM FACE

VIEW OF DAM (APRIL, 1965)

EXHIBIT E-7

APPENDIX F

GEOLOGY

LAKE COMO DAM

APPENDIX F

GEOLOGY

The Lake Como Dam and reservoir area are located within the Glaciated Allegheny Plateau Section of the Appalachian Plateau Physiographic Province. The site is about 6 miles northeast of the axis of the Northern Anthracite field of Pennsylvania. Deposits of glacial drift of variable thickness cover the entire area. The drift was deposited by the Wisconsin Ice Sheet during the Pleistocene period of geologic time.

The glacial drift is composed primarily of till which is a reddish brown, unsorted, compact mixture of clay, silt, sand, gravel, and cobbles with occasional boulder size pieces. The stone pieces are sub-angular to rounded and consist mainly of sandstone and siltstone derived from the Catskill Formation, the dominant rock formation in the area. The clay content and compact nature of the till makes it a relatively impervious soil type. The dam abutments are underlain by such till.

Some deposits of glacial outwash and Kame terraces are also found in the area. These deposits are composed of loose, poorly sorted to stratified deposits of silt, sand, and gravel. The Kame and outwash deposits are generally very pervious.

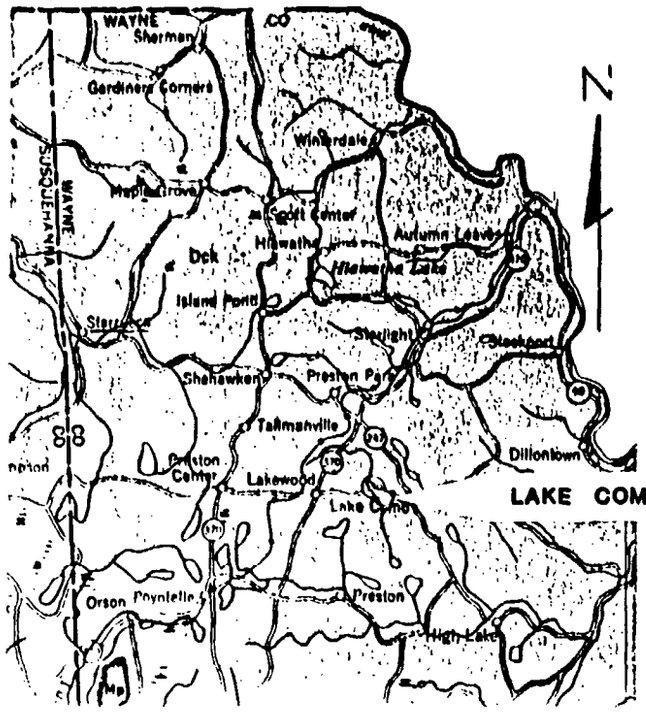
Other loose pervious soils in the area are the recent deposits of alluvial silt, sand, and gravel with some clay. These soils are localized and limited to streambeds and flood plain areas.

The bedrock underlying the entire dam and reservoir area is the Catskill Formation of the Susquehanna Group. The group of formations is of Upper Devonain age. The Catskill strata generally consists of well indurated, red shale, siltstone and fine sandstone with some gray, green, and brown shale, siltstone and sandstone layers. Occasional conglomeratic layers are encountered. The red shales are the dominant lithology and the residual soils derived from this rock are usually high in clay and silt content. The dry stone walls at the dam site were built with Catskill boulders.

The regional structure of the bedrock in the area indicates that the bedrock underlying the dam and reservoir area is gently folded (dip 1^{o}NW) to near-horizontal. The regional strike of the folds is N55^{o}E.

Although depth to bedrock at the dam site is unknown, frequent large slabs of sandstone in the stream channel and both banks suggest near surface bedrock.

Ref.: Ground Water of Northeastern Pennsylvania, Stanley W. Lohman, 1937; Bulletin W-4, Pennsylvania Geologic Survey.



0 1 2 3 4 5 10 MILES

SCALE: 1" = 4 MILES

LEGEND

DEVONIAN

UPPER

CENTRAL AND EASTERN PENNSYLVANIA

Dos — **Oswayo Formation**
Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses; includes red shales which become more numerous eastward. Relation to type Oswayo not proved

Dck — **Catskill Formation**
Chiefly red to brownish shales and sandstones, includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east

Dm — **Marine beds**
Gray to olive brown shales, graywackes, and sandstones, contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock, Tully Limestone at base

Ds — **Susquehanna Group**

Barbed line is "Chemung-Catskill" contact of Second Pennsylvania Survey County reports; barbs on "Chemung" side of line

NOTE:
GEOLOGIC MAP AND LEGEND OBTAINED FROM GEOLOGIC MAP OF PENNSYLVANIA BY PA. TOPOGRAPHIC AND GEOLOGIC SURVEY, DATED 1960

PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE COMO DAM
GEOLOGIC MAP

GEO - Technical Services, Inc.
HARRISBURG, PA

AUGUST , 1981

EXHIBIT F